CHAPTER 10

SPECIALISED INSTITUTIONS

10.1 NATIONAL INSTITUTE OF SOLAR ENERGY (NISE)

10.1.1 National Institute of Solar Energy (NISE), an autonomous institution under MNRE, is the National Research and Development (R&D) institution in the field of Solar Energy. NISE is mandated for Solar R&D, solar component testing and certification, capacity building, and development of solar products and applications. NISE complements the requirements of MNRE to make India into a self-reliable renewal power-producing nation and accept the series of challenges that intervened amidst the implementation of the National Solar Mission (NSM). NISE also carry out research and development activities in the areas of green Hydrogen. The institute is situated at Gwal Pahari on the Gurugram-Faridabad Road, Haryana.

10.1.2 NISE has established itself as a leading Institute in the field of Solar Energy through Resource Assessment, Research & Development, Design, Development and Demonstration of Solar Energy Technologies for various applications such as, Testing, Certification and Standardization, Monitoring and Evaluation, Economic and Policy Planning, Human Resource Development and Active collaborations with prominent National & International organisations

10.1.3 NISE is maintaining state of the art Solar Photovoltaic module testing laboratory, lighting system test laboratory, battery testing facility and solar water pumping system test rig and outdoor test facilities. The institute also has a fully developed testing facility for small and large size Solar Thermal Systems and Solar Resource Assessment.

10.1.4 RESEARCH & DEVELOPMENT

Details of various R&D projects undertaken by NISE during the year are given in Table 10.1

Table 10.1 Details of ongoing R&D projects

S.No.	Project	Project Objecctives	Funding Agency
1	Design, development and qualification of large area (156 mm x 156 mm), secondary reference solar cells	To develop a large area (156 mm x 156 mm) secondary reference solar to replace a conventional small area (20 mm x 20 mm) secondary reference solar cell	DST
2	Optimization of Solar Photovoltaic Based' Water Pumping Performance with DC Motor	To carry out optimization studies for solar photovoltaic based water pumping with DC motor	SERB TARE
3	High-Efficiency Solar Water Pumping Systems	To increase the 'Overall Wire to Water Efficiency' of the Solar Water Pumping Systems (SWPS) up-to 45% (from the existing level of around 38%-40%)	MNRE

S.No.	Project	Project Objecctives	Funding Agency
4	Setting up of a Centre of Excellence on Hydrogen Energy at National Institute of Solar Energy (NISE), Gwal Pahari, Gurugram	To operate and maintain the existing PV based green hydrogen production cum dispensing station at NISE To augment the green hydrogen production capacity to 15 Nm3/hr from the existing 5 Nm3/hr	MNRE
5	Study of solar powered micro-irrigation farming	To assess the utility of solar powered micro-irrigation systems for farming in Indian conditions	NISE
6	Indoor Solar Cooker	To develop a solar cooking system for indoor cooking by using Solar PV with thermal storage	NISE
7	Sand based Thermal Space Heater	To develop a Space Heating system by using Solar PV with Sand based thermal storage	NISE
8	Instant Solar Geyser	To develop a solar water heating system by using Solar PV with thermal storage	NISE
9	Performance Analysis of Bifacial Module at NISE	To compare the performance of bifacial module with mono facial module at different tilt.	NISE
10	Framework (guidelines & testing criteria for re-use) for secondary life PV module	To develop a guideline to choose PV modules for secondary use or recycling after its lifetime declared by manufacturer.	NISE
11	Recycling of PV module	To develop tools for onsite recycling of PV modules	NISE
12	Degradation forecasting of PV module using machine learning followed by power plant rating	To develop a procedure for forecasting the degradation of PV module as per different climatic stress conditions	NISE
13	Development of I-V translation procedure for bifacial module for outdoor conditions	To develop a I-V translation procedure to estimate the degradation of bifacial module in outdoor conditions.	NISE
14	R & D on Agri-photovoltaic system	To analyze the radiation data of existing bifacial power plant Designing a pilot agri-photovoltaic system with tracking.	NISE
15	Micro grid/ Local Grid:	To minimize the Grid/ Genset uses To maximize the renewable generation and utilization.	NISE

10.1.5 DESIGN, DEVELOPMENT AND QUALIFICATION OF LARGE AREA (156 MM X 156 MM) SECONDARY REFERENCE SOLAR CELL

The work on stabilization of solar cells is undergoing and the second phase of development of anodized aluminium casing has been started. This will be an improved working model. A design for this improved casing has been finalized and is under production process. This new model is an advancement over earlier one (Fig. 10.1). The new model boasts four temperature sensors, better cable management, better protection against environmental factors, better solar cell placement arrangement and placement of screws in line with the body (Fig. 10.2).

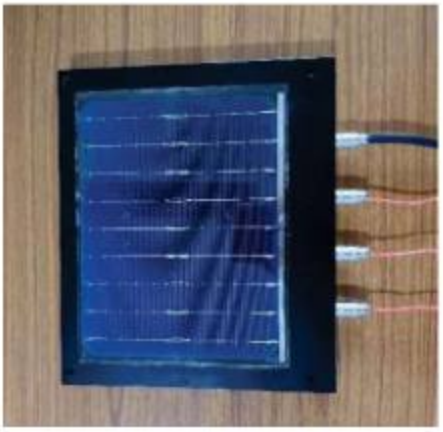


Fig. 10.1: Secondary Reference Solar Cell Package developed at NISE

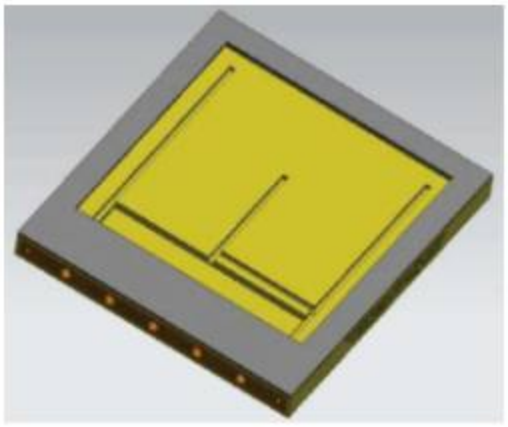


Fig. 10.2: Top View of the newly designed anodized aluminium package

Experiments also have been perform to eliminate the impact of oxygen-related thermal donor defects. For this, a vacuum annealing process has been developed and repeated on several wafers. As a result, an optimized process has been achieved to reduce the impact of these defects. The enhancement of minority carrier lifetime of such wafers has been estimated to be enhanced by 22.92% (Fig. 10.3).

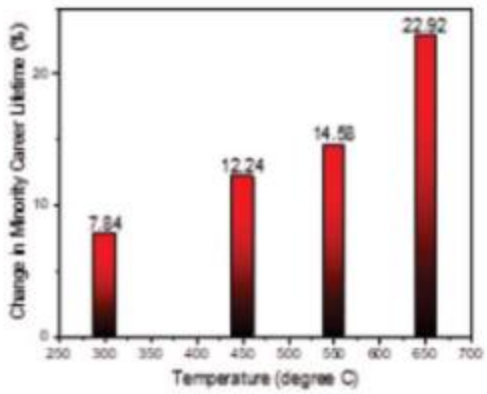


Fig. 10.3: Change in Minority Career Lifetime for bare silicon wafers with Temperature when Vacuum annealed for 120 Minutes

10.1.6 OPTIMIZATION OF SOLAR PHOTOVOLTAIC BASED WATER PUMPING PERFORMANCE WITH DC MOTOR

Experiments were conducted for submersible pump of different capacity of power and various total dynamic head conditions. The available test facility at NISE can perform up to 400 m of total dynamic head with appropriate actuator valve arrangements. Fig. 10.4 shows the schematic diagram of submersible pump test rig.

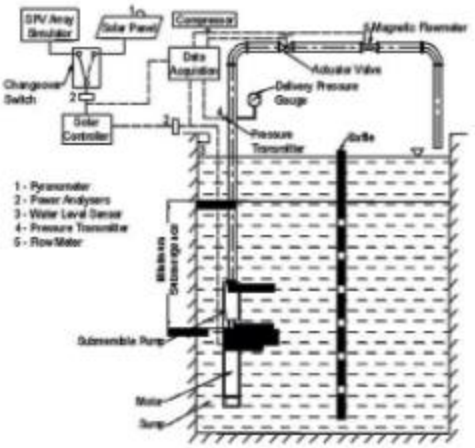


Fig. 10.4 Schematic diagram of submersible pump test rig

Performances of individual components are necessary to estimate the losses in each system. In order to understand the existing system, few experimental readings were taken for analysis. In general, there are two ways of testing the solar pump, i.e. through outdoor reading, where power for the motor will be taken from PV module with suitable solar controller. Tracking of sun radiation will be through manual or auto tracking method. Another way of conducting the solar pump testing is indoor method, where the power is fed through DC programmable power supply of capacity 15 kW. There are hot and cold profile data which has irradiance, temperature of module, and ambient temperature. That information will be fed to DC programmable power supply for testing the solar pump.

Fig. 10.5 shows the variation of solar pumping parameters such as tilt irradiance, PV module temperature, ambient temperature, voltage, and current from the PV module along with the flow rate with reference to the time on one particular day.

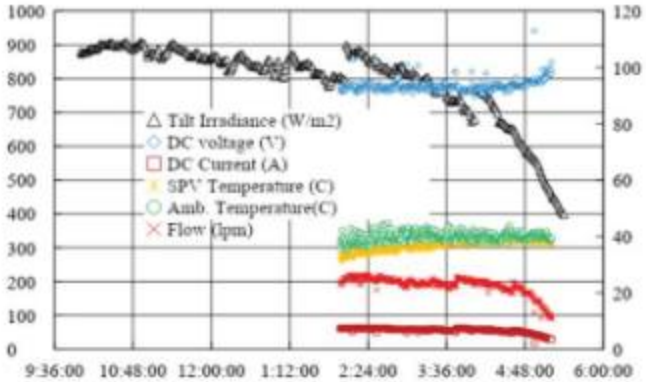


Fig. 10.5 Solar pumping parameters

Fig. 10.6 shows various efficiencies of solar pumping system for 1 hp helical pump at 90 m of total dynamic head. The efficiency of inverter is in the range of 82% to 85%, whereas the efficiency of motor-pump set is around 63%. The wire to water efficiency is found to be 58% with PV module efficiency 16% to 18%. The overall efficiency (from irradiance to the hydraulic energy) of the solar water pumping system is about 8% to 10%, which clearly depicts that there are huge losses in the overall system and there is scope for development of more efficient solar pumping system for optimum usage in all the aspects.

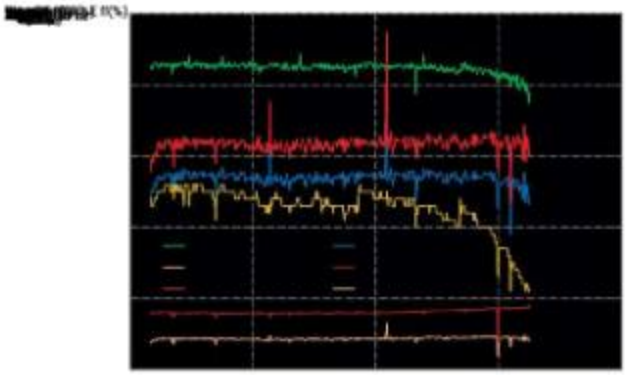


Fig. 10.6 Efficiencies of individual components in solar pumping system

Performances of individual components are necessary to estimate the losses in each system. In order to understand the existing system, few experimental readings were taken for analysis. In general, there are two ways of testing the solar pump, i.e. through outdoor reading, where power for the motor will be taken from PV module with suitable solar controller. Tracking of sun radiation will be through manual or auto tracking method. Another way of conducting the solar pump testing is indoor method, where the power is fed through DC programmable power supply of capacity 15 kW. There are hot and cold profile data which has irradiance, temperature of module, and ambient temperature. That information will be fed to DC programmable power supply for testing the solar pump.

10.1.7 HIGH-EFFICIENCY SOLAR WATER PUMPING SYSTEMS

The main objective of this MNRE funded project is to increase the 'Overall Wire to Water Efficiency' of the Solar Water Pumping Systems (SWPS) up-to 45% (from the existing level of around 38%-40%) and creation of a state-of-the-art testing facility for SWP system. The project was completed successfully in February 2023 with the below deliverables:

Establishment of state-of-the-art testing and R&D facility for solar water pumps: The state-of-the-art testing and R&D facility has been developed at NISE. The test facility is unique of its kind and can test solar water pumps up to 50 HP capacity (The lab as shown in Figure 10.7). Solar array simulators have been installed for hot and cold profile testing and manual module mounting structures as well as automatic tracking structures have been installed for regular testing activities as well as for various R&D activities.



Figure 10.7: Solar water pump lab

Enhancing efficiency & water output of solar water pump controllers: Solar Water Pump Controller Efficiency is affected by change in temperature, radiation, and head. Tests has been conducted in NISE's SWP lab to find out the parameters that affect the controller efficiency and to enhance the part-load efficiency which occurs at intermediate/partial radiation and head/load. In addition, NISE studied the impact of different module technologies on the system performance, e.g., tested the solar water pump with bifacial modules to enhance the daily water discharge.

Testing accuracy of remote monitoring system for solar water pumping applications: Tests for comprehending the accuracy of remote monitoring systems have been performed. NISE found that even though voltage, current, and power were measured accurately, an error was reported in measuring the flow rate, i.e., there is a huge difference between the reported flow rate (via the RMS system) and the measured flow rate.

Designing and testing micro-irrigation system: Various micro-irrigation system has been tested and based on the analysis a draft specification for less than 1 hp pumps has been prepared and shared with MNRE and stakeholders for their comments and suggestions. Low Cost and High Efficiency, Portable & Rugged 'Micro Irrigation Systems' with small motor pump prototype from junk has been developed for demonstration purpose.

Test protocols and specifications: Test protocols have been prepared for solar water pumps up to 50 hp capacity. Framework of guidelines for solar based micro pumps for 0.1 hp is ongoing. Also, a joint report was prepared in collaboration with industry on ways to increase daily water output of a solar water pumping system using bifacial PV modules.

10.1.8 SETTING UP OF A CENTRE OF EXCELLENCE ON HYDROGEN ENERGY AT NATIONAL INSTITUTE OF SOLAR ENERGY (NISE), GWAL PAHARI, GURUGRAM

The main objective of the project was to operate and maintain the existing solar powered green hydrogen generation and dispensing station already established at NISE campus. The project also included augmenting green hydrogen production capacity by setting up an additional 10 Nm3/hr electrolyser. During the year, augmentation of green hydrogen production capacity was undertaken with the addition of a 10 Nm3/hr alkaline electrolyser. NISE is in the process of reviving the existing station and integrating the new electrolyser to the dispenser.

10.1.9 SOLAR POWERED MICRO-IRRIGATION SYSTEM

This innovative project aims to demonstrate the effectiveness of using solar energy to power micro-irrigation systems, promoting sustainable agricultural practices and efficient water usage. This project is installed at NISE in collaboration with M/s. Spowdi, India under the MOU signed between NISE and Spowdi (India) for three years in 2022. his project serves as a real-world demonstration of how renewable energy can enhance agricultural productivity while conserving vital resources like water. Real-time monitoring of multi-crops yield (with vegetables like, cabbage, tomatoes, chilies, radish, turnip, okra etc.), water usage, humidity, temperature and solar energy production is being done to analyse system performance and gather data for future improvements. The average pump run time is 86 minutes to irrigate the complete cropping area 352.5 sq. meter. This system is ideal for farms with up to one-acre size because it is lightweight, portable, and simple to install. The area of 23.5 m x 15 m used for farming with multi-cropping style. Total 28 rows are formed with an area of 4.5 sq. meter per row.

The lightweight, portable system that weighs just 15 kilograms in total and is easy to install and handle by one person. It is durably built to withstand tough conditions such as daily movement, high temperatures, dirt and muddy water.

Main objective of this project is to study the effectiveness of solar-powered micro-irrigation systems considering below parameters:

- Annual crop yield.
- Required water (L) per day for irrigation.
- How much LPM (Flow Rate) is required to irrigate the land in one day.
- Pump running time to irrigate the land.
- Number of days pump run in previous year.



Fig. 10.8 Solar based micro-irrigation farm at NISE

This system is so energy efficient that a small solar panel (150W) is enough to deliver sufficient water per hour with high and stable pressure, making it perfect for small-scale farmers with up to one acre of land. This solar-powered system is optimized for drip irrigation and saves farmers time which is consumed by traditional methods for irrigation, giving farmers and their families more time to engage in other life-enriching activities.

10.1.10 INDOOR SOLAR COOKER

NISE is working on the development of Indoor Solar Cooker which has three components: PV panels, connecting wires with a DC heater, and Thermal storage with a cooking pot. The system converts solar energy to electrical energy using solar PV, which is then converted into thermal energy by heating an element made up of nichrome wire installed in the solar pot. The thermal energy storage is made of cast iron block and the heater elements are inserted at the bottom of the cooking pot. The heat stored is then used to cook food products.

After initial success in achieving temperatures sufficient for cooking, the NISE team is making efforts to make the cooker compatible to be used with utensils.

10.1.11 SAND BASED THERMAL SPACE HEATER

NISE is working on development of a Sand based Thermal Space Heater which can be used for space heating in winters. This heat energy is absorbed by the thermal energy storage made from fine Sand. Heat is stored in the sand during the day as draft tube inlet is blocked which can later be removed at night. The high temperature sand releases its heat to indoor air through natural convective heat transfer facilitated by the draft tube.

10.1.12 INSTANT SOLAR GEYSER

NISE is working on development of Instant Solar Geyser which has three components: PV panels, connecting wires with a DC heater, and Fine Sand as a Thermal storage. The thermal energy storage is made of Stainless-Steel cylinder filled with sand and the heater elements are inserted at the middle of the geyser. The water heating tube installed in a helical shape is inserted in the sand battery; as water flows through tube heat is absorbed from the surrounding sand and increases water temperature. Experiments are also being performed with thermic oil as energy storage.

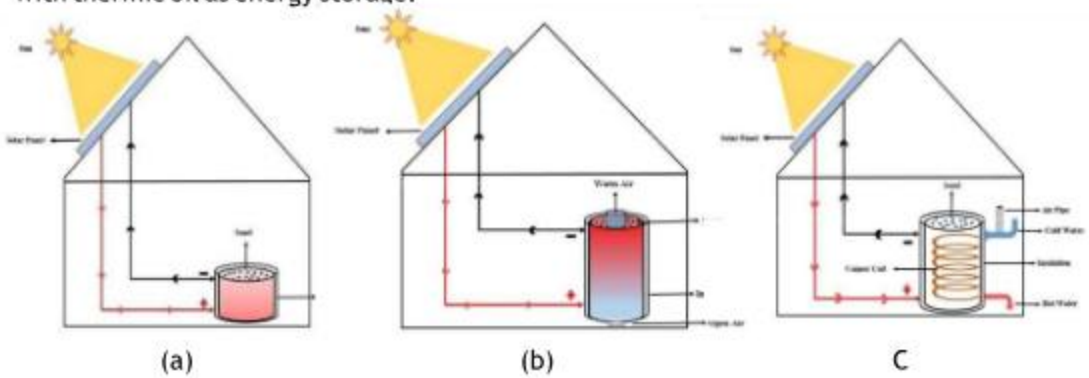


Fig. 10.9: Schematic and Working of (a) Indoor Solar Cooker system (b) Space Heating system (c) Instant Solar Geyser system

10.1.13 PERFORMANCE ANALYSIS OF BIFACIAL MODULE AT NISE

NISE has installed 5kWp bifacial power plant at vertical east-west facing, 5 kWp bifacial module at tilt equal to latitude south facing and 10 kWp mono-facial module at latitude tilt south facing to analyse its energy generation. A preliminary report was already published, work going on to analyse the degradation and long-term performance of the power plant. Fig. 10.10 shows the bifacial power plant installed at NISE.



Fig. 10.10: Bifacial PV power plant at vertical tilt

10.1.14 FRAMEWORK (GUIDELINES & TESTING CRITERIA FOR RE-USE) FOR SECONDARY LIFE PV MODULE

The reuse of photovoltaic (PV) modules after their expected lifetime can contribute to reducing waste and promoting sustainability in the solar energy sector. While PV modules typically have a lifespan of 25 to 30 years, they can still have value and potential applications beyond that period. For using the module after the manufacturer warranty period or first lifetime, the PV modules need to go through a procedure for reliable second lifetime. NISE is developing a guidelines & testing criteria for re-use of PV module for secondary use.

10.1.15 RECYCLING OF PV MODULE

PV modules are required to recycle after its useful lifetime. At present there is no cost-effective proper guideline for recycling of PV module in India. NISE is developing onsite recycling tools for PV module to reduce the transportation cost. Work is going on to develop the proto-type design.

10.1.16 DEGRADATION FORECASTING OF PV MODULE USING MACHINE LEARNING FOLLOWED BY POWER PLANT RATING

The degradation of PV module is one of the major areas to understand to estimate the LCOE of the power plant before installation. The degradation of PV module depends on the environmental stress, mechanical stress and voltage stress during its lifetime. NISE is working to develop a procedure for forecasting the degradation of PV modules as per different stress conditions. Fig. 10.11 shows a flow chart for forecasting the degradation of PV module.

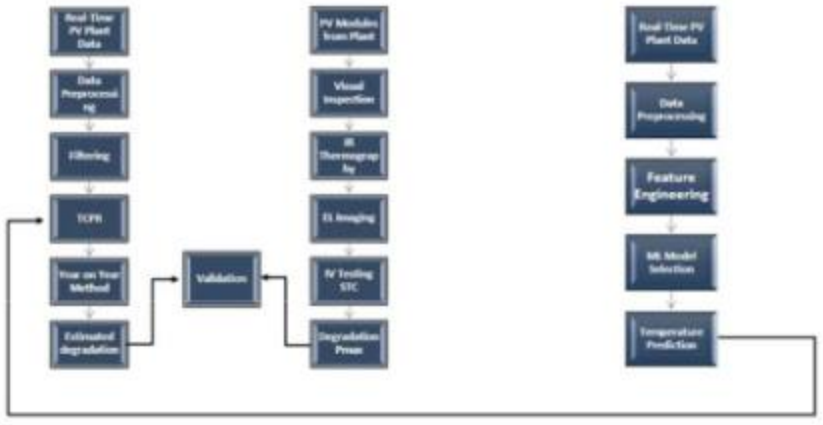


Fig. 10.11: Flow chart for modelling of forecasting degradation rate of PV modules

10.1.17 DEVELOPMENT OF I-V TRANSLATION PROCEDURE FOR BIFACIAL MODULE FOR OUTDOOR CONDITIONS

Understanding the behaviour of PV module in outdoor conditions is not that easy as of mono-facial module. At present there is no proper procedure to translate the I-V data of PV module at a temperature & irradiance condition to other reference conditions. NISE is working to develop a I-V translation procedure to estimate the power degradation rate of bifacial module in outdoor conditions.

10.1.18 R&D ON AGRI-PHOTOVOLTAIC SYSTEM

The performance analysis of PV module in agri-PV system is a recent topic of study. NISE has already worked to understand the agri-PV system and micro-climatic conditions below the modules both for mono-facial as well as bifacial module. Work is going on to analyse the radiation data of existing bifacial power plant and also planning to set up a pilot agri-photovoltaic system for bifacial module with tracking.

10.1.19 MICRO GRID/ LOCAL GRID

NISE has a state-of-the-art infrastructure for distributed RE system testing, which includes a Power electronics laboratory, solar lighting system, Solar water pumping system, and photovoltaic indoor and outdoor test facility. Power Electronics lab (PEL) for testing all types of power converters and distributed power plants of capacity 850 kWp, 300 Kwp are with storage and the rest are in grid feeding mode. For the reliable operation of the labs, there should be 24 X 7 power, with the aim that the institute should minimize the Grid/ Genset uses, and maximize the renewable generation and utilization. However, max utilization can only be possible by using the Battery backup system as a reference at no grid condition, and on the same line, other grid-feeding plants and other available sources (DG Genset) can feed the electricity as per the load demand as per generation logic control. On the above line, NISE has designed, devolved, and installed an AC Bus coupled local grid. This widens the way for the study of solar generation prediction, source & load management, power quality issues, and the possibility of autonomous operation in an emergency for the institutes involved in the critical process.

10.1.20 TESTING & STANDARDIZATION

10.1.20.1 Advanced Solar Cell Characterization Facility

NISE has state-of-the-art Advanced Solar Cell Characterization Laboratory with ISO class 8 clean room facility. The lab housed several advance cell characterization tools including i) Spectral Response Measurement System (QE-SRMS), ii) Spectroscopic Ellipsometer, iii) Optical Microscope, iv) Semi-Automatic Four Probe resistivity meter, v) Electrochemical Capacitance Voltage (ECV) Profiler, vi) Surface Profilometer and vii) Field Emission Scanning Electron Microscopy (FESEM) with EDS facility.

The lab uses instruments for measuring textured and thin film solar cell optical constants. The facility has equipment for Automatic single and multi-point mapping of sheet resistance and resistivity of silicon wafers and solar cells, measuring film thickness, roughness and 2- dimensional stress, surface texture, laser ablation and LBSF microstructure analysis of front side metallisation. The facility is also capable of measuring the optical, morphological, and electrical properties of silicon wafers and solar cells. The laboratory has the capability of doing testing as per the following standards:

- IEC 60904-1:2020 - Photovoltaic devices - Part 1: Measurement of photovoltaic current-voltage characteristics.
- IEC 60904-7: 2019 - Photovoltaic devices - Part 7: Computation of the spectral mismatch correction for measurements of photovoltaic devices.
- IEC 60904-8: 2014 - Photovoltaic devices - Part 8: Measurement of spectral responsivity of a photovoltaic (PV) device.



Fig. 10.12: Advanced Solar Cell characterization laboratory with ISO class 8 clean room facility at NISE

10.1.20.2 PV Module Testing Laboratory

NISE has a PV module testing laboratory and maintain it as per ISO 17025:2017. The facility is also recognised by Bureau of Indian Standard (BIS) for PV Module Testing as Type 2 category facility. At present the lab is offering testing for following test standards:

Standard No.	Details
IEC 61215-1-1: 2016/ IS 14286-1-1: 2019	Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-1: Special requirements for testing of crystalline silicon photovoltaic (PV) modules
IEC 61215-1-2: 2016/ IS 14286-1-2: 2019	Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-2: Special requirements for testing of thin-film Cadmium Telluride (CdTe) based photovoltaic (PV) modules
IEC 61215-1-3: 2016/ IS 14286-1-3: 2019	Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-3: Special requirements for testing of thin-film amorphous silicon based photovoltaic (PV) modules
IEC 61215-1-4: 2016/ IS 14286-1-4: 2019	Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-4: Special requirements for testing of thin-film Cu (In,GA)(S,Se)2 based photovoltaic (PV) modules
IEC 612151-1- 2021	Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-1: Special requirements for testing of crystalline silicon photovoltaic (PV) modules
IS/IEC 61701: 2011 and IEC 61701:2020	Salt mist corrosion testing of photovoltaic (PV) modules
IEC 61853-1	Photovoltaic (PV) module performance testing and energy rating - Part 1: Irradiance and temperature performance measurements and power rating
IEC 61853-2: 2016 ' (spectral response only for solar cell or representative module)	Photovoltaic (PV) module performance testing and energy rating - Part 2: Spectral responsivity, incidence angle and module operating temperature measurements
IEC 61853-3:2018	Photovoltaic (PV) module performance testing and energy rating - Part 3: Energy rating of PV modules.

Standard No.	Details
IEC 61853-4:2018	Photovoltaic (PV) module performance testing and energy rating - Part 4: Standard reference climatic profiles.
IEC TS 62804-1:2015	Photovoltaic (PV) modules - Test methods for the detection of potential-induced degradation - Part 1: Crystalline silicon
IEC TS 60904-1-2:2019	Photovoltaic devices - Part 1-2: Measurement of current-voltage characteristics of bifacial photovoltaic (PV) devices
IEC 60904	Reference Module calibration: c-Si reference module calibration up to the size 600 Wp
In-house test procedure	Testing of PV Module cleaning devices as per Test procedure developed by NISE
IEC 60904	Solar simulator characterization/calibration
IEC TS 63342:2022	C-Si photovoltaic (PV) modules - Light and elevated temperature induced degradation (LETID) test - Detection
IEC 63202-1:2019 (module also)	Photovoltaic cells - Part 1: Measurement of light-induced degradation of crystalline silicon photovoltaic cells
IEC TS 62782:2016	Photovoltaic (PV) modules - Cyclic (dynamic) mechanical load testing
In-house test procedure	Testing as per customer requirement for different products related to solar PV: Nano-coating, Quantum boost device
In-house test procedure	Long term field exposure test of PV modules
In-house test procedure	Qualification plus testing, Bankability testing of PV module in the lab as per customer requirement

During this year, the laboratory has upgraded its facilities with addition of following equipment

- Dynamic mechanical load tester
- Test set for Solar simulator characterization
- Test set up for performance test of PV module at different angle
- Chiller for environmental chambers
- Fire test facility



Fig. 10.13: Test set up for performance test of PV module at different angle at NISE

10.1.20.3 Power Electronics Laboratory

Power Electronics Laboratory (PEL) at NISE accomplishing testing as per ISO/IEC 17025: 2017. The lab is equipped for testing of all types of power conditioning units (PCUs) up to 100 kVA including hybrid, standalone, Grid-tied inverters (GI), and Pump Controllers. The facility is also recognized by BIS for IS 16169: test procedure of islanding prevention measures for utility-interconnected photovoltaic inverters. The lab under takes the following NABL accredited tests as per IEC/IS standards:

Table No. 10.3

Standard No.	Details
IEC 61683:1999	Photovoltaic systems - Power conditioners - Procedure for measuring efficiency
IS 16169/ IEC 62116:2008	Test procedure of islanding prevention measures for utility - interconnected photovoltaic inverters
CEI IEC 61727:2004	Photovoltaic (PV) systems - Characteristics of the utility interface
IS16797:2019/ IEC 62509:2010	Battery charge controllers for photovoltaic systems - Performance and functioning of the charge controller
EN50530:2010	Overall efficiency of grid connected photovoltaic inverters
IEC 60068-2 -1: 2007	Environmental test A: Cold
IEC 60068-2 -2: 2007	Environmental test B: Dry heat
IEC 60068-2 -14:2009	Environmental test N: Dry heat change of temperature
IEC 60068-2 -14:2005	Environmental test Db: Damp heat cycle



Fig. 10.14: Power Electronics Laboratory setup at NISE

10.1.20.4 Battery Test & Characterization

Battery Test & Characterization at NISE is involved in testing the performance, reliability and life cycle of major secondary battery storage technologies, including Lead-acid, Nickel-Cadmium and Lithium-Ion Batteries. The laboratory is equipped with the latest technologies like deep cycle battery testers, a programmable power supply, advanced hardware and software, a data logger, and a temperature-controlled water bath. The laboratory is also recognised by BIS for IS 16270: 2014- secondary cells and batteries for solar photovoltaic application general - requirements and methods of test services. The lab under takes the following tests as per IEC/IS standards

Table No. 10.4

Standard No.	Details
IS 16270:2014	Secondary cells and batteries for solar PV application- general requirements and methods of test
IS 1651:1991	Stationary cells and batteries, lead acid type (with plante positive plates)
IS 13369:1992	Stationary lead acid batteries (with Tubular positive plates) in Monobloc Containers
IS 15549:2005	Stationary Valve Regulated Lead Acid Batteries- Specification
IEC 61427	Secondary cells and batteries for PV energy systems- General requirements and methods of test
IS 16047 (Part 3): 2018	Secondary Cells and Batteries Containing Alkaline or Other Non-Acid Electrolytes-Secondary Lithium Cells and Batteries for Portable Applications Part 3 Prismatic and Cylindrical Lithium Secondary Cells, and Batteries Made From Them (First Revision)



. 10.15: Battery Test & Characterization Laboratory setup at NISE

10.1.20.5 Advanced SPV system & lighting laboratory

Solar Photovoltaic (SPV) and Lighting laboratory at NISE is a well-established lab for performance and reliability testing of off-grid solar applications. The laboratory is equipped for testing as per below standards:

- IES LM-79-08/IS 16106: 2012 - Method of Electrical and Photometric Measurements of Solid-State Lighting products
- Testing of solar lighting systems as per MNRE specifications
- Testing the remote monitoring system of solar lighting

The lab is also equipped to carried out test of solar lighting system as per customer specification.



Fig. 10.16: Solar light testing facility at NISE

10.1.20.6 Solar Water Pump Test Facility

The state-of-the-art testing and R&D facility has been developed at NISE. The test facility is unique of its kind and can test solar water pumps from 0.1 hp to 50 hp capacity. The facility is used for testing of all major pump technologies such as submersible, surface, AC and DC systems as per national and international standards. The laboratory has also tested pumps under innovative Distributed Renewable Energy (DRE) solutions for rural livelihood applications. The solar water pump division also facilitates for undertaking R&D activities in solar water pumping systems. NISE is also involved in creating awareness on PM-KUSUM scheme.

Table No. 10.5

Sr. No.	Details of test set up	
1	Min. Capacity for testing submersible pumps (Simulator & outdoor)	0.1 hp,
2	Max. Capacity for testing of submersible pumps (Simulator & outdoor)	50 hp
3	Total no. of test slots	14
4	Max. head for testing submersible pumps (Simulator & outdoor)	400 m
5	No. of Automatic module mounting structure	3
6	No. of manual module mounting structure	15
7	Min. Capacity for testing surface pumps (Simulator & outdoor)	0.5 hp
8	Max. Capacity for testing of surface pumps (Simulator & outdoor)	10 hp,100 m

Detailed design of Experimental test set up: Fig. 10.17 shows the schematic diagram of submersible pump test rig with instrumentation. The sump has a capacity of 420 m3 to avoid the reheating of water (10 m x 6 m x 7 m). The flow rate through the pump is measured through Electromagnetic flow meter and the delivery pressure of submersible pump is measured through pressure transmitter of Yokogawa make. The test rig is constructed as per Indian standard IS 9137, IS11346 and MNRE guidelines for performance testing on submersible pump.

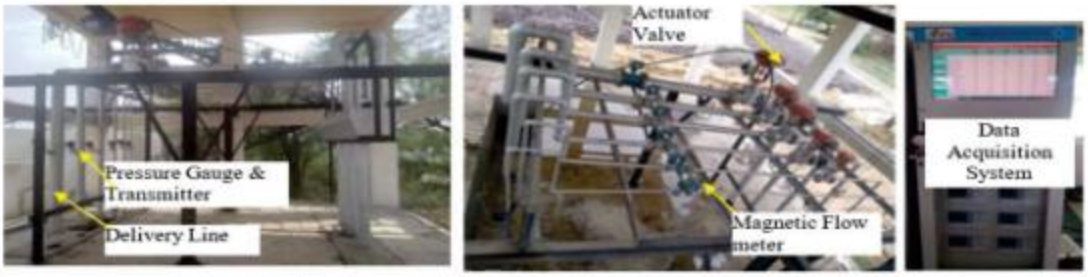


Fig. 10.17: Experimental test rig of submersible pump

10.1.20.7 Solar Radiation Calibration Laboratory (SRCL)

Solar Radiation Calibration Laboratory (SRCL) at NISE has been operational since 2016 to calibrate solar radiation measuring sensors from the National solar radiation network of MNRE. The laboratory was established following the World Meteorological Organisation (WMO) guidelines, where calibration was performed as per the ISO standards. It has a highly precise reference standard sensors such as the primary standard sensor/Absolute Cavity Radiometer (Highest Solar Radiation Standard) and a number of secondary standard reference sensors for achieving radiometric calibration traceable to the World Radiometric Reference (WRR) scale with high accuracy and precision. The calibration facility at NISE can now transfer the latest radiometer calibration factors to the radiometric sensors from industry. In 2023-24 (till Nov 2023), 18 sensors were calibrated at Solar Radiometric calibration facility of NISE.



Fig. 10.18: Pyranometer Calibration facility at NISE

10.1.21 SKILL DEVELOPMENT AND CAPACITY BUILDING

National Institute of Solar Energy provides an opportunity to empower oneself and build in worldwide capacity building through skill development programs, training, short-term courses, and client-specific courses on various renewable energy technologies. In this current climate changing directions, the proposed mandate helps to meet the challenges, maintain quality, and modernize the young people worldwide. NISE has organized numerous technical training programs for renowned academics, professionals, and members of the industry. The participants from both domestic and foreign countries have learned through the specific training curriculum introduced under various training programs in NISE.

NISE has taken several initiatives towards skill development and capacity building activities. Under the Ministry's flagship program "Suryamitra" a total of 4858 Suryamitras were trained in the field of installation and maintenance of the solar photovoltaic systems during year FY 2023-24 through Training partners/ Centres spread all over the country.

NISE has provided short-term training courses that are tailored to the needs of the participants to a wide range of government departments, schools, colleges, military forces, nodal agencies, and public sector undertaking companies. These trainings have been delivered both online and offline. International training programs for sustainability were organized with specially designed training sessions were held in FY 2023-2024 to improve knowledge transfer. There were six national and five international training courses held, with 277 individuals (102 foreign and 175 national). The details of the national level training program conducted at NISE for the FY 2023-24 are given in Table below.

Table 10.6 - Skill development programs conducted at NISE during FY 2023-24

Sr. No.	Training/ Program	Number of Programs	Duration of Program (Days)	Date	Number of Participants
1	Engineer Trainees Azure Power Pvt. Ltd	1	5	10th - 14th July 2023	26
2	Engineer Trainees Renew Pvt. Ltd.	2	5	18th - 22nd Sep 2023 09th to 13th Oct 2023	34 36
3	NABL Training Program	1	3	17th to 19th Oct 2023	14
4	Military Engineer Services Training Program	1	5	20th - 24th Nov 2023	35
5	DRE Workshop	1	1	21st Nov 2023	30
	TOTAL	6			175

10.1.21.1 Training program for industry and public sector units

The NISE Skill Development Division also provides training programs tailored to the employment roles, expertise, and future needs of participants from business, academia, other organizations, and ministries who are willing to work in the field of solar energy technologies. These specially tailored training courses are created based on the individual skill requirements of the industry/organization and the participants' experience level. These courses are made with the fundamental skill requirements in mind, such offering practical experience and theoretical concept knowledge. The start-up India initiative, solar photovoltaic applications, solar industry business models, prospects for entrepreneurs in the solar sector, and other topics were all covered in this tailored training session. NISE has held training sessions for Azure Power Pvt. Ltd., Renew Pvt. Ltd., MES officials, and NABL officers during FY 2023-2024. In all, 175 people took part in the customized training course held at NISE. Fig. 10.19 and 10.20 display the participants in the Renew Pvt. Ltd. Training Program and the NABL Training Program, respectively.

There were six national and five international training courses held, with 277 individuals (102 foreign and 175 national). The details of the national level training program conducted at NISE for the FY 2023-24 are given in Table below.



Fig. 10.19 Participants in the Renew Pvt. Ltd. Training Program



Fig. 10. 20 Participants of NABL Training Program

10.1.21.2 International training program of solar energy technologies and application under Indian Technical Economic Co-operation (ITEC)

The Indian Ministry of External Affairs fully funds NISE's for conducting annual three-week Indian Technical and Economic Co-operation (ITEC) programs. In FY 2023-2024, NISE conducted ITEC & e-ITEC program, training 102 participants from various countries. Additionally, the program offered a global forum for knowledge exchange among participants in the field of solar energy. Fig. 10.21-10.22 displays the ITEC program participants. Table below provides a breakdown of the delegates' involvement in the ITEC and e-ITEC training program.

Table 10.7 - International Participation of delegates in ITEC and e-ITEC for FY 2023-24

Sr. No.	Training/ Program	Number of Programs	Duration of Program (Days)	Date	Number of Participants
1	ITEC Programme on Solar Energy Technologies & Application	4	21	07th Aug - 27th Aug 2023 25th Sep - 15th Oct 2023 28th Nov - 18th Dec 2023 08th Jan - 28th Jan 2024	16 21 30 27
2	e-ITEC Programme on Solar Energy Technologies & Application	1	5	19th - 23rd Sep 2022	8
	Total	**5**			**102**



Fig. 10.21-10.22 ITEC program participants

10.1.21.3 Future prospects and development

NISE plans to launch new, organized courses in areas including data analytics, electric vehicle design and development, power electronics converter design and development, and solar training programs that leverage artificial intelligence and machine learning. International training programs with improved hands-on instruction and organized modules will be arranged by NISE. In addition, NISE is organizing comprehensive courses on energy storage, hydrogen storage, solar photovoltaic, and solar thermal technologies for the upcoming year. In the future, NISE intends to carry on hosting online training sessions.

10.1.22 OUTREACH ACTIVITIES

10.1.22.1 Approved List for Models and Manufacturers (ALMM)

To ensure reliability of Solar PV products and to protect the consumer interests and ensure better energy security of the country, MNRE on 02.01.2019, has issued "Approved Models and Manufacturers of Solar Photovoltaic Modules (Requirements for Compulsory Registration) Order, 2019". The order provides for the enlistment of eligible models and manufacturers of solar PV cells and modules complying with the BIS Standards and publishes the same in a list called the "Approved List of Models and Manufacturers" (ALMM). Only the models and manufacturers included in this list will be eligible for use in Government/ Government assisted Projects/Projects under Government Schemes & Program, installed in ions and carrying out inspections, verifications, and quality checks on behalf of MNRE.

As on 31st March 2024, a total of 83 manufacturing plants are enlisted in ALMM with a cumulative installed manufacturing capacity of 34 GW/Year (33,994 MW/Year). 17 manufacturing plants have an installed manufacturing capacity greater than 500 MW/Year with cumulative installed manufacturing capacity of 26.78 GW/Year which is 78.8% of the total installed manufacturing capacity enlisted under ALMM.

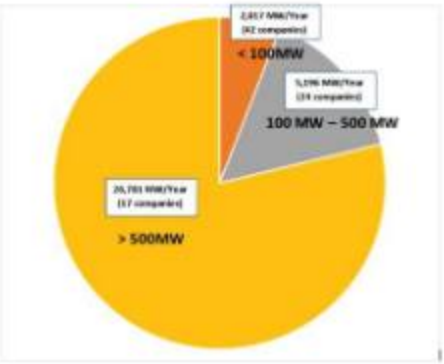


Fig. 10. 23 Capacity-wise distribution of ALMM inspected companies

10.1.22.2 Technical Consultancy Services

NISE offers various consultancy services pertaining to all domains of solar energy technologies, such as Solar photovoltaic, Solar thermal, green hydrogen, and balance of systems. The division provides specialised technical services to stakeholders, i.e., facility owners, investors, financial institutions, armed forces, banks, etc., for various aspects of solar project implementation and performance mapping.

NISE has offered consultancy services on technical vetting, field inspection and field testing for solar projects in the year 2023-24. Due diligence studies on a specific block of Solar PV power plant at Neyveli solar park was carried out. NISE is also providing technical support to Solar Energy Corporation of India (SECI) for development, validation and implementation of qualitative requirement and acceptance test procedures for setting up of 3000 MW per annum cells and module manufacturing facility in India. In this duration NISE technical team was engaged in field level testing of PV modules and batteries for various organizations. NISE is partnering with UNICEF (India) for the implementation of solar based solutions for the public health care facilities (HCF) in India under the project "Sustainable innovations for clean energy in immunization and primary health care in India". Under this project, a mobile app was developed for the baseline energy assessment and solarization of HCFs, and various HCF were visited for sample-based data assessments.



Fig. 10.24: Testing Services by NISE Technical Team at GEDA Goa



Fig. 10.25: Testing Services by NISE Technical Team at Guwahati



Fig. 10.26: NISE Team engaged in Data assessment of Health Care Facilities in U.P \as a part of UNICEF project

10.1.23 ADMINISTRATION AND FINANCE

The Government of India has sanctioned 41 regular posts for NISE, including the post of Director General. NISE is registered under Society Registration Act 2012 in Haryana. The affair of Society is administered, directed and controlled by Governing Council in accordance of rules, regulation and bylaws of the society, which are duly approved by administrative Ministry i.e. MNRE. Secretary MNRE is president of Society (NISE) and Director General is Principal Executive Officer of the Society (NISE).

The funds of the Society are managed by following Sources:

(I) Core Grants made by Government of India for furtherance of the objects of Society.

(ii) Contribution from other Sources like various projects.

(iii) Income from Investments.

(iv) Receipts of the society from revenue generation activities like testing, consultancy, Skill development activities etc.

NISE is following the General financial Rules 2017, Fundamental and Supplementary Rules and such other rules (mutatis mutandis) as applicable to Central Government.

10.2 NATIONAL INSTITUTE OF WIND ENERGY (NIWE)

10.2.1

National Institute of Wind Energy (NIWE) is a technical arm of the Ministry for the smooth development of the wind energy sector in the country. NIWE's main activities include Wind (onshore & offshore) and Solar Resource Assessment; preparation of standards for wind turbines; testing and certification of wind turbines and associated systems; information dissemination; human resource development; and offer various consultancy services to customers. The major activities of NIWE during this period are given below:

10.2.2 OFFSHORE WIND DEVELOPMENT

Met-Ocean measurements in Gulf of Mannar

The MNRE has sanctioned a project to NIWE with the objective of quantifying the wind potential of Gulf of Mannar towards demarcating the offshore wind energy blocks.

Under the project, 3 sites have been identified to map offshore wind resource in Gulf of Mannar, Tamil Nadu coast on priority. The details of the site are given below.

Lidar Location

Location	LiDAR Serial number	Latitude/Longitude
VOC_Port_1	ZX300M-996	8° 44' 58.2" N /78° 13' 36.19" E
VOC_Port_2	ZX300M-997	8° 45' 19.58" N/78° 13' 16.24" E
UDANGUDI	ZX300M-998	8°23'35.763"N / 78°8'0.686"E



Fig. 10.27: Lidar Installed at VOC Port 1 and VOC Port 2, Gulf of Mannar, Off Tamil Nadu coast



Fig. 10.27: Lidar Installed at Udangudi Thermal coal Jetty, Gulf of Mannar, Off Tamil Nadu coast

The Installation and commissioning of LiDAR at above mentioned sites have been completed and measurement are under progress. One-year wind measurement campaign will be completed by February 2025.

10.2.3 WIND & SOLAR RESOURCE MEASUREMENTS

Wind Resource Assessment (WRA) programme data is being used widely to identify the potential site for establishment of Wind Farms in the country. Under this programme of the Ministry, 915 dedicated wind monitoring stations & 115 dedicated Solar Radiation Resource Assessment stations have been established with the support of State Nodal Agencies & other institutions.

Preparation of 150m Hybrid Map

Prepared a Wind-Solar Hybrid Map by combining the wind potential map at 150 meters above ground level and the solar atlas prepared by NIWE. The Wind-Solar Hybrid Map was successfully published by the Secretary, MNRE during Global Wind Day on 15th June 2023. The Wind-Solar Hybrid Map Portal was successfully launched by the Secretary, MNRE on 16th June 2023, at NIWE in Chennai.

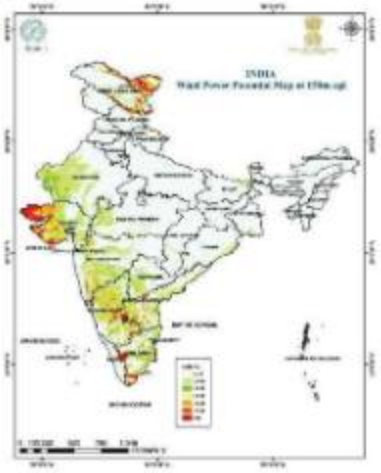
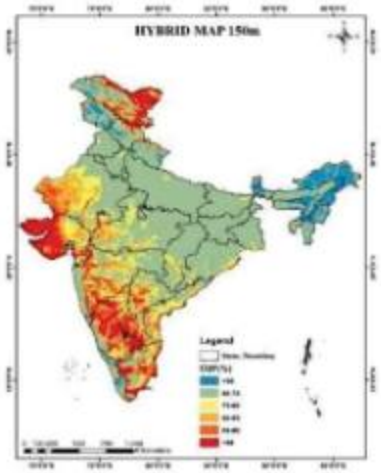


Fig. 10.28: 150 m Wind Power Potential Map



Hybrid Map 150m

LiDAR-based Offshore Wind Measurement at Kadamat Island, Lakshadweep

NIWE has successfully commissioned an offshore LiDAR (Light Detection and Ranging) system at the NIOT desalination plant building located at Kadamat Island, Lakshadweep an advanced remote sensing technology that uses laser pulses to measure wind speeds and directions at various heights, making it suitable for offshore wind resource assessment. The LiDAR system deployed at Kadamat Island is capable of capturing wind data up to several hundred meters above the surface, providing a comprehensive profile of the wind resource. This data is crucial for evaluating the feasibility and optimal design of potential offshore wind energy projects in the region.



Fig. 10.29: Installation of LiDAR at Kadamat Island

10.2.4 WIND TURBINE TESTING STATION (WTTS)

TESTING

The testing facilities are certified as per the requirements of ISO 9001:2015 and accredited as per the requirements of ISO / IEC 17025:2017. In the year 2023-24, testing of 3 wind turbine models are in progress. Further, Measurements for a 3.3 MW Wind Turbine located at Gujarat was initiated. NIWE has successfully undergone the NABL onsite surveillance audit as per ISO / IEC 17025:2017 held on 23rd and 24th September, 2023 at WTTS, Kayathar and NABL has recommended for continuation of accreditation.

Inter Lab Comparison (ILC)

As per MNRE Lab Policy, an Inter Lab Comparison (ILC) on Electrical Characteristics Measurements (ECM) as per IEC 61400-21 with 5 Laboratories viz., DNVGL, Windguard, UL, Profec Ventus, NIWE was organized. All labs are within the Z-Score requirements of ISO/IEC 17043.

Technical Co-operation

To establish India's first Test Centre for Offshore Wind Turbines at Dhanuskodi, Rameshwaram district, Tamil Nadu, NIWE along with DTU & DEA of Denmark under the INDEP program had organized an internal Workshop on "Efficacy Study" for Dhanuskodi Site on 2nd May 2023 at NIWE, Chennai.

10.2.5 STANDARDS AND CERTIFICATION

Certification

NIWE obtained International accreditation for the certification services as per the requirements of ISO/IEC 17065:2012 from the National Accreditation Board for Certification Bodies (NABCB), Quality Council of India during the year 2020 and the accreditation valid up to 15th April 2023. The accreditation has been subsequently renewed and the validity of the Accreditation has been extended up to 15 March 2027.

The continuation of the Accreditation for the certification services has benefited the wind industry to avail accredited certification services for wind turbines within India in line with International practices and has created visibility for NIWE amongst international accredited certification bodies.

Standards & Regulation

NIWE is involved in the preparation of Indian standards on wind turbines by supporting Bureau of Indian Standards (BIS). BIS is the National Standards Body which issues Indian standards. A committee viz., Wind Turbines Sectional Committee (ETD 42) has been formulated by BIS for the preparation of Indian standards and to carry out the standards related works on wind turbines, under the Chairmanship of Director General, NIWE. Standard & Regulation division of NIWE, which is part of BIS ETD 42 committee, provides the technical support to BIS on a continuous basis in all the standards related works. Based on the contribution, Thirty Indian standards on wind turbines have been finalized, so far. During the period (01st April, 2023 to 31st March 2024), Seven Indian standards have been finalized by Wind Turbines Sectional Committee (ETD 42) of BIS.

Revised List of Models and Manufacturers of Wind Turbines (RLMM):

MNRE has been issuing Revised List of Models and Manufacturers of wind turbines (RLMM) periodically for the healthy and orderly growth of wind power projects in the country. S&R division, which is part of RLMM committee, has been providing support to MNRE in verification of documentation submitted along with application and in handling RLMM related works. During the year, review of documentation has been completed for 35 RLMM applications of various wind turbine models and the review comments have been submitted to MNRE / RLMM committee.

Prototype Wind turbine Models

NIWE is implementing MNRE guidelines on installation of prototype wind turbine models in India which facilitates the installation of Prototype wind turbine models to carry out the Type Testing for obtaining type certificate. NIWE has formulated a committee to take a suitable decision on issuing the recommendation letters. During the period (from 1st April 2023 to 31st March 2024), NIWE has issued the recommendation letter in connection with grid synchronization for one prototype wind turbine model, with a rated capacity 5200 kW for the purpose of Type Testing.

Quality Management System:

Director & Division Head, S&R as a Management Representative (MR) carried out various preparatory works in maintaining the QMS of NIWE as per ISO 9001:2015 standard. During the period, successfully undergone the First periodic audit of quality management system on 01.08.2023 & 14.08.2023 as per ISO 9001:2015 at WTTS Kayathar and NIWE, Chennai respectively. Based on successful completion of the first periodic audit, DNV recommended the continuation of the ISO certificate issued to NIWE.

10.2.6 SKILL DEVELOPMENT AND TRAINING

NIWE has conducted the following three customized training courses for

- 18 officials of M/s. NTPC Limited (online course) were trained on "Wind Energy Technology and its Applications" during 4th July to 7th September 2023.
- 28 officials of M/s Renew Power Pvt. Ltd. were trained on "Wind Energy Technology" during 25th to 30th September 2023.
- 45 officials of M/s Renew Power Pvt. Ltd. were trained on "Wind Energy Technology" during 08th to 13th January 2024.

NIWE has conducted the following three days national training course :

- 25th National Training Course during 21st to 23rd February 2024 and trained 50 participants from 9 States of India.

NIWE has conducted the following three International training courses on "Wind Turbine Technology and Applications" under ITEC sponsored by Ministry of External Affairs, Government of India:

- 27th International Course during 4th to 20th October 2023 and trained 23 participants from 13 ITEC countries.
- 28th International Course during 29th November to 15th December 2023 and trained 21 participants from 12 ITEC countries.



Fig. 10.30: 28th ITC Participants at NIWE Campus

- 29th International Course during 24th January to 09th February 2024 and trained 28 participants from 11 ITEC countries.

10.2.7 AZADI KA AMRIT MAHOTSAV

NIWE with the support of MNRE has conducted 07 different category of events, which was Webinars, Awareness Programme, Interactive Session and Technical Paper Presentation as part of Azadi Ka Amrit Mahotsav to commemorate 75 years of progressive Independent India during the financial year 2023-24. 472 participants were participated in these events.



Fig. 10.31: Awareness Programme for School Teachers under AKAM

10.2.8 VAYUMITRA SKILL DEVELOPMENT PROGRAMME

During 2023-24, NIWE has successfully conducted two batches of Training of Trainers (ToT) programmes and trained, assessed, and certified 52 trainers. In addition, 31 Training of Participants (ToP) programmes have been completed and trained 930 participants under VSDP.



Fig. 10.32:Training of Trainers programme of Vayumitra Skill Development Programme



Fig. 10.33:Training of Participants programme of Vayumitra Skill Development Programme

10.2.9 STUDENT VISIT AT NIWE CAMPUS

NIWE has arranged and coordinated campus visits to create awareness and to motivate students towards research on wind energy, achieving indigenization and also to create an awareness about the activities and services of NIWE among the students. 1580 students were benefitted from this arrangement during 2023-24.

10.2.9 STUDENT VISIT AT NIWE CAMPUS

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Fig. 10.34 : Students visit at NIWE Campus

10.3 SARDAR SWARAN SINGH NATIONAL INSTITUTE OF BIO-ENERGY (SSS-NIBE)

Sardar Swaran Singh National Institute of Bio-Energy (SSS-NIBE), Kapurthala is an autonomous Institution under the Ministry of New and Renewable Energy (MNRE), Govt. of India, set up as an apex Institution for carrying out state-of-the-art research and developmental activities, biomass resource assessment, testing, validation and training for promotion of bioenergy in the country.

During this year, the institute took key initiatives to further extend R&D activities in bio-energy and bioproducts. The research findings have been published in reputed journals of the frontier bioenergy area. Furthermore, the Institute participated in all technical programs and meetings of MNRE, particularly related to bioenergy sector for activities such as recent research developments, strategy and policy, progress and dissemination of knowledge and technology in the area. The activities taken during the FY 23-24 are given as:

10.3.1 Externally Funded projects

SSS-NIBE has been awarded three research projects from CPRI, Bengaluru, one project from MNRE and one project from MoEF. The project wise details are as follows:

Project title	Funding Agency	Project Cost	Start w.e.f.	Project Duration
Composition analysis of different types of pellets/briquettes received from unknown sources (PI Dr AK Sarma; Co-PI Dr Vandit Vijay)	Central Power Research Institute, MOP	Rs 37,00,000	Mar 2022	1 year
Complete heating and emission analysis of raw biomass and pellets during combustion (PI Dr Kuwar Pal; Co-PI Dr AK Sarma)		Rs 66,00,000	Mar 2022	2.5 years
Complete Ash Analysis of biomass pellets and co-combusted fuels (PI Dr AK Sarma; Co-PI Dr Tapas K Patra)		Rs 2,70,00,000	Mar 2022	3 years
Densification of agro-waste and assessment for its application in the gasifier (PI Dr Tapas K Patra; Co-PI Dr Sachin Kumar)		Rs 40,45,320	Mar 2022	2.5 years
Advanced Microalgal Biorefinery approach for the recycling of domestic sewage wastewater for a cleaner and greener Indian Himalayan region' funded by National Mission on Himalayan Studies (NMHS), G.B. Pant National Institute of Himalayan Environment (NIHE) Kosi Katarmal, Almora - 263643, Uttarakhand, India (Under the Ministry of Environment, Forest and Climate Change (MoEF CC), Govt. of India). (PI Dr Sachin Kumar; Co-PI Dr Sanjeev Mishra)	MoEF	Rs 96,75,520	July 2023	3 years

The project titled "Composition analysis of different types of pellets/briquettes received from unknown sources" is mainly concerned with forming a regression-based method to obtain the composition of an unknown pellet or briquette.

This research study carried out as part of SAMARTH mission for co-firing of biomass in thermal power plant. This project has relevance to thermal power plants to ensure maximum utilization of paddy straw in pellets for co-combustion and solution for stubble burning. The objective of the project is to find the percentage of paddy straw in unknown biomass pellets, which involved finding the right biomarker that would determine the percentage of paddy straw in unknown biomass pellets. In this regard Ion chromatography tests were performed on biomass samples containing varying fraction of paddy straw to determine Fluoride, Bromide, Phosphate, Chloride, Sulphate, Nitrate, and Nitrite concentration. 120 experiments were carried out by manipulating the paddy straw percentage (0-100%) to create a robust dataset. Linear Regression was carried out to correlate ion concentrations with varying percentages of paddy straw in the mixtures. Based on the analysis, it was found the fluoride is one biomarker that could be used to determine the percentage of paddy straw in unknown biomass pellets. The data is represented in the below figure.

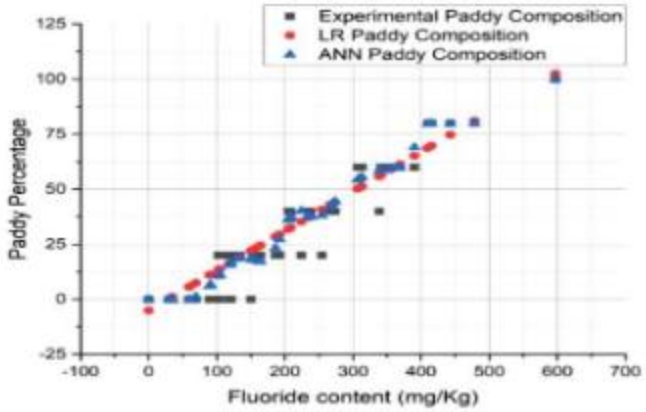


Fig. 10.35: Fluoride content in biomass pellet containing varying fraction of paddy straw

The project titled "Complete heating and emission analysis of raw biomass and pellets during combustion", and is concerned with the burning rate, thermal efficiency and emission analysis with the pellets during combustion and to generate a database and recommendation for appropriate thermo and environmental analysis for meeting the desired standards. Biomass samples native to Punjab, Jammu and Kashmir and Himachal Pradesh and Uttarakhand (wheat stalk, rice stalk, pine etc.) were collected to determine the burning rate, thermal efficiency etc. of the biomass samples. Basic characterization (Proximate, ultimate and calorific value) of the pure biomass samples has been completed.

The project titled "Complete ash analysis of biomass pellets and co-combusted fuels" is concerned with studying the ash fusion behaviour and obtaining the various metallic oxides, halides and sulphur present in the ash. Also in this project, work will be done to generate a database and to recommend appropriate blending proportion of biomass pellets with coal to meet the desired standards. Biomass samples eg. variety of rice stalk, variety of wheat stalk, mustard stalk, groundnut stalk, bagasse, corn stalk, cotton stalk, saw dust, sweet sorghum, etc. from various parts of Punjab and Haryana have been collected. Ash was prepared using BS EN ISO 18122: 2015 standards and SEM-EDS and XRD studies were done to observe their morphology and composition.



Fig. 10.36:Biomass samples from Punjab and Haryana, and their respective ash samples

Some of the equipment sanctioned under these projects are already commissioned (Automatic Proximate Analyser) and the rest are in the process of procurement. Also, 26 different varieties of bamboo species native to the state of Tripura were collected to study their potential as fuel source and to study their ash properties. North-eastern states of India account for around 28% of the India's bamboo stock and Tripura has 23% of its geographical area covered with bamboo forests. There is immense scope for utilizing waste bamboo and unused bamboo of Tripura and northeast India for charcoal production and subsequent use in coal-based powerplants. A MoU was signed between Tripura Forest Department and SSS-NIBE for knowledge exchange. Proximate analysis of the bamboo samples were performed and ultimate analysis will be performed shortly. Calorific values of the bamboo samples will also be obtained. A study shall be carried out to check the suitability of bamboo species for combustion, gasification, pyrolysis etc.



Fig. 10.37: Various bamboo species sourced from Tripura: solid and powdered form

For the MNRE sponsored project titled 'Densification of agro-waste and assessment for its applications in the gasifier', significant work has been done for completion of objectives of the project in this year.



Fig. 10.38: Samples of different biomass collected of densification

The biomass which are included in the project were procured as shown above. Detailed characterization of six agro-waste viz. paddy straw, corn cob, sweet sorghum, millet, cotton stalk and mustard crop residue has been carried out. The physio-chemical characterization i.e., ultimate analysis (C, H, N, S, O), proximate analysis (moisture, VM, fixed carbon & ash) and gross calorific value of the biomass have been done. A few organic binders have been identified viz. molasses, press mud, water hyacinth, cow dung, poultry waste etc. for their characterization. The further work is focused on the investigation of effects of size of the biomass and influence of binders and their characteristics and properties on biomass. The work for the other objectives is under progress aligned with the timeline of the project.

The newly awarded project from National Mission on Himalayan Studies, MoEF&CC, Govt. of India titled "Advanced microalgal biorefinery approach for recycling of domestic sewage/wastewater for cleaner and greener Himalayan region", is a collaborative project with NIT Hamirpur and implementing agency being Jal Shakti Vibhag, Hamirpur, at one of its Sewage Treatment Plant (STP), Hamirpur.

The project aims to develop a sustainable process to treat domestic sewage wastewater using algal and conversion of harvested algal biomass into biogas, biocrude, biochar, and high-value products. The agal cultivation process and the optimization study will be done in a 2000 L open raceway pond at SSS-NIBE. Further, the optimized process will be scaled-up in a 5000 L open raceway pond at STP, Hamirpur. The harvested biomass will be converted into biofuels using existing pilot-plant anaerobic digester installed at SSS-NIBE. In addition, the project will help manpower and skill development and conduct technoeconomic analysis of the overall process for further scale-up under pilot plant and commercialization through technology transfer.

10.3.2 Activities under Thermo-chemical Conversion Division

During the year, research has been carried out in the areas of biomass cook stoves to improve their thermal performance and emission characteristics. The performance of different improved cook stove models has been investigated in the cook stove testing laboratory. Performance of biomass- based dryers systems was also evaluated experimentally. Work has been initiated to address major ash related issues such as corrosion, agglomeration, ash fusion due to silica melting, alkali induced slagging biomass co-firing. Different biomass samples including but not limited to paddy straw, biomass pellets, briquettes, mustard, cotton stalk, municipal solid waste pellets etc. have been characterized to determine their elemental composition and calorific value. Work on the bio-char production, characterization and development of lab scale bio-char production unit has also been initiated.

10.3.2.1 Improved biomass cook-stove testing and certification

SSS NIBE have a well-equipped improved biomass cook stove test center, to cater cookstove manufacturers in Northern India and especially for the of Punjab, Haryana, Himachal Pradesh, Jammu & Kashmir and Uttrakhand region. Pictorial depiction of the existing facility is given below. The test facility is due for up-gradation and this activity will be taken up in the next financial year.

Various cook stove models were received for testing and certification purpose at the laboratory. This activity was carried out as part of testing services being offered to the industry. The testing was carried out followed as per BIS 2013 protocol.



Fig. 10.39: Biomass cookstove testing facility at SSS-NIBE

10.3.2.2. Advance biomass cookstove testing, demonstration and dissemination in collaboration with Fire and Combustion Research Center (FCRC), Jain University, Bengaluru

A MoU between SSS-NIBE and Jain University was signed in Sept, 2022, involving activities such as demonstration of advanced and fuel-efficient biomass stoves/combustors for multiple end user application, initially in the state of Punjab and subsequently in other states in India. This is essentially to popularize the use of waste biomass/agricultural residue to economically meet energy and heat requirements at both domestic and industrial level. For the same, the initial design of biomass stoves/combustors that has been developed and patented by FCRC, Jain University shall be adopted. Based on the requirement analysis in Punjab, the stove/combustor design would be suitably modified/scaled-up to suit end application. FCRC, Jain University shall act as the knowledge partner in this project and provide the technology of biomass stove/combustor and also supply these devices by themselves or through their authorized manufacturer. FCRC would also support SSS-NIBE in disseminating knowledge through public outreach programs such as training, workshop, demonstrations, consultations, seminars, etc. As a result of this collaboration between the two parties, SSS-NIBE's scientific staff would benefit from expertise in advanced stove design, scale-up, and its implementation/operation.



(a) Size: 1.5 kg/hr, Type: Vertical, Forced draft cookstove

(b): Size: 3.5 kg/hr, Type: Vertical, Forced draft cookstove



© Size: 15 kg/hr, Type: Vertical, Forced draft cookstove

(d) Size: 3.5 kg/hr, Type: Horizontal, Forced draft cookstove

Fig. 10.40: Advance biomass cookstoves received from FCRC, Jain University Bengaluru

In continuation with above work agenda of the MoU, five nos. of improved biomass cookstoves of different capacities (1.5 kg/hr, 3.5 kg/hr and 15 kg/hr) and types (horizontal and vertical) has been received from FCRC. Before dissemination of the cookstove models in the field, the testing of different cookstove models under laboratory conditions is underway. Also, the potential end users for field demonstration are being identified. Based on the satisfactory performance report of laboratory testing, cookstove models of appropriate capacity will be disseminated among the identified end users.

Improved Cookstove Dissemination

During the month of November 2023, an improved biomass cookstove model was disseminated in the field. Based on the requirements of end user, cookstove was disseminated in the field for a time bound period and for performance evaluation during field testing. Data collection from field testing is ongoing. The details of end user and photograph of cookstove dissemination is given below:

Primary School, Ibban, Kapurthala, Punjab
One forced draft cookstove was disseminated at Primary School, Ibban, Kapurthala, Punjab, during the month of November 2023.

Mid-day meal of approximately 90 students is being prepared on daily basis by using this cookstove.



Fig. 10.41: Improved cookstove dissemination activity at SSS-NIBE, Kapurthala

10.3.2.3. Biochar Kiln

Biochar - a beneficial soil conditioner and carbon negative material. Instead of indiscriminate burning, paddy straw can be converted into biochar for soil conditioning purposes. In this regard, a biochar kiln was constructed using bricks and mortar, equipped with a chimney and fan to burn off volatiles, among other components. Initial trials have commenced. Yield using paddy straw - 27%. Further experiments will be conducted in the next financial year. Characterization of the biochar and assessment of the system's emission profile are pending.



Fig. 10.42: Biochar kiln - paddy straw converted to biochar

10.3.3. Activities under Biochemical Conversion Division

During the year, several in-house R&D projects were developed by scientists and the research team in the division. The major focused area includes the Scaling up of integrated biorefinery using paddy straw, Upgradation of biogas to BioCNG via microbial electromethanogenesis, sequential dark and photo fermentation for hydrogen generation from paddy straw and exploration of novel lignocellulolytic enzymes for biorefinery applications etc. The details of these projects are discussed below.

10.3.3.1. Thermophilic anaerobic consortium enrichment for enhanced biogas/ biomethane Production

A research work has been carried out to enhance the biogas production from Napier grass using thermophilic consortium at 52°C using 5-10%, w/v solid loading and 10-30% (w/w) developed thermophilic consortium. The daily biogas production was measured by supplementing with varying concentration of different minerals. An enhanced biogas production by up to 20% was observed with some of the minerals. It has been observed that the samples amended with minerals showed increased biogas yield than control by increasing the metabolic activity of the microorganisms inside the digester. However, no significant change was observed in the methane content from minerals-supplemented biogas plants.

10.3.3.2. Biogas production from different feedstocks

Biogas potential of different agricultural residues was studied by using in-house developed consortium THERMI-NIBE V.1. Feedstocks of banana pseudo-stem, kans grass, mustard stalk, corn cob, corn stover were analysed and lab scale biogas plants were set up by using THERMI-NIBE V.1 providing thermophilic conditions. Banana pseudo-stem and corn stover have a very good biogas potential and hence these could be used to produce biogas on large-scale. Likewise, biogas potential of potato waste (peel & flesh) obtained from chips industry was investigated using THERMI-NIBE
V.1. Overall, it could be concluded that such wastes have a good potential for H2/CH4 production.

10.3.3.3. Upgradation of biogas to Bio CNG via microbial electro methanogenesis

Different techniques such as Water Scrubbing, Pressure Swing Adsorption, Chemical absorption, Cryogenic Separation, Membrane Separation, Biological Techniques etc. are being used for the upgradation of the biogas to bio CNG. The division has selected Microbial Electro methanogenesis technique for the upgradation of biogas on the basis of the advantages of the technique over the others. In this process, methane is produced by reducing carbon dioxide by the biocatalysts in the presence of imposed potential. The system consists of an anodic and cathodic chamber typically divided by a proton exchange membrane (PEM) for the transport of ions i.e., protons. The protons are generated in the anodic chamber and are carried to the cathodic chamber through PEM where reduction reaction takes place leading to the production of methane. In this way, CO2 present in the raw biogas is utilised for upgradation.

A jacketed double chambered bioreactor has been designed for the upgradation of biogas via microbial electromethanogenesis and is under the process of fabrication.



Fig. 10.43: Research work being carried out at Biochemical Conversion Division

10.3.3.4. Integrated approach of Sequential dark and photo fermentation for hydrogen generation from paddy straw

Enhancement of H2 yield using approach of dark and photo fermentation is being explored by researchers; however, the reported level of H2 production using dark and photo fermentation is still insufficient as a commercially competitive energy resource. Moreover, some studies support the use of integrated dark and photo fermentation to produce bio-hydrogen continuously with high yield. This study aims to develop an efficient method for the conversion of lignocellulosic waste in biohydrogen via utilization of with sequential dark and photo fermentation using Enterobactersp. and Rhodobactercapsulatus. Currently, establishment the process of dark fermentation with paddy straw biomass is going on with different parameters. Pretreatment of paddy straw was done by different concentrations of NaOH and these samples were further treated by the enzymatic saccharification process. The effect of saccharification was analysed by the amount of reducing sugar present in the samples. Lab-scale biohydrogen plants were setup in a controlled environment of 37°C and hydraulic retention time (HRT) of 15 days. All the plant setups containing Enterobacte aerogenes showed hydrogen generation. It was observed that the E. aerogenes could be a successful strain for the dark fermentation process and enhance the yield of hydrogen generation.

10.3.3.5. Exploration of lignocellulolytic enzymes producing thermophiles from hot springs of Western Himalayan region for biorefinery applications

The project "Exploration of lignocellulolytic enzymes producing thermophiles from hot springs of Western Himalayan region for biorefinery applications" is funded by DST under KIRAN scheme. In the current project, a total of twenty-three lignocellulolytic enzymes producing bacterial strains were isolated from different hot-springs of Western Himalayan Range (Manikaran, Kasol, Tattapani). Based on experiments, five bacterial strains (NIBE 9, NIBE 10, NIBE 11, NIBE 13 and NIBE 23) showed cellulose-solvent zones around colonies in cellulose agar plate after incubating 24 h at 55° C. The characterization of cellulase producing bacterial strains was done on the basis of biochemical and 16S rDNA molecular typing at the species level.

The strain NIBE 9, NIBE 11, NIBE 13 and NIBE 23 showed 99.86%, 100%, 99.86% and 99.93% similarity with Bacillus licheniformis. The isolate NIBE 10 showed 100% similarity with Bacillus smithi. The phylogenetic tree of all the bacterial isolates was constructed on the basis of neighbor-joining algorithm. Growth and cellulase production profile of B. licheniformis NIBE23 and B. smithi NIBE10 were studied and it was found that the production broth when inoculated with 1%, (v/v) of inoculum of B. licheniformis NIBE23 produced optimal amount (enzyme activity: 20.3 U/ml, DCW 3.5 g/l) of cellulase at 24 h post inoculation at 55°C under continuous shaking. For the production profile of B. smithi, the production broth was inoculated with 1%, (v/v) of inoculum of B. smithi at 55°C under continuous shaking (150 rpm) upto 36 h. The maximum amount of cellulase production (14. 57 U/ml) and DCW (2.9 g/l) was observed at 22 h. Optimization of different conditions for maximum cellulase production from B. licheniformis NIBE23 was carried out. The culture conditions like pH, temperature, carbon sources, and nitrogen sources were optimized.

10.3.4. Activities under Chemical Conversion and Electrochemical Process Division

In order to curb the problem of utilizing noble metal electrocatalyst in energy devices such as fuel cell, supercapacitor, batteries and water electrolyser research is oriented towards developing biomass based electrocatalyst as an alternative to conventional material. Electrochemical Division at SSS-NIBE developed some biomass-derived carbon materials i.e., Biochar and activated Carbon from a variety of biomass such as Rice Straw, Corn Cob, and Potato Peels.

Developed Carbon material from Rice Straw Developed Carbon material from Corn

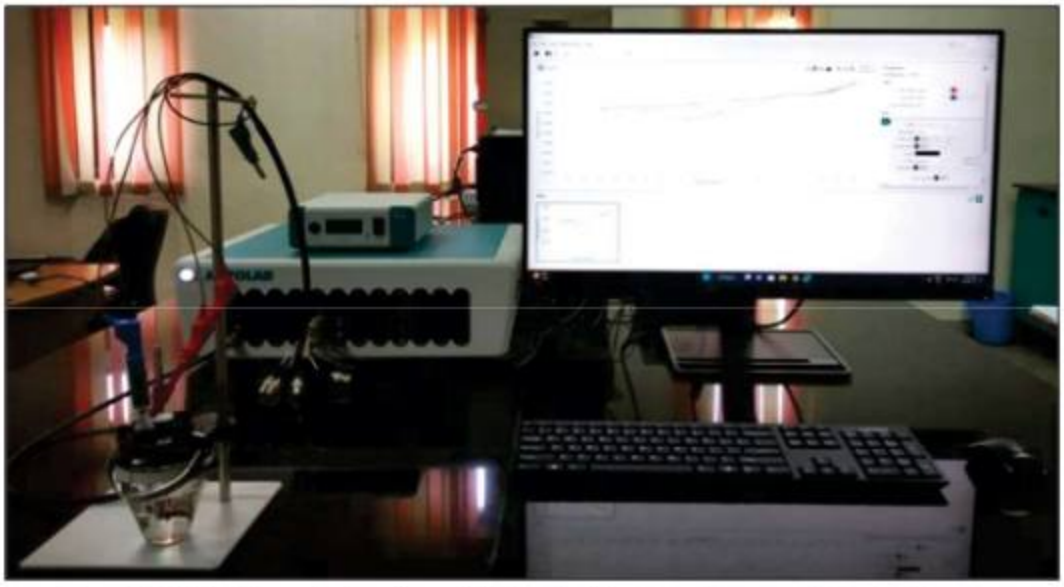


Fig. 10.44:Testing of developed Activated Carbon from variety of biomass for Energy Device application in Electrochemical Division, SSS-NIBE

10.3.5. Activities under Biomass and Energy Management division

The Biomass and Energy Management Division (BEMD) at SSS-NIBE has initiated new activities in the last one year with the induction of two new scientists dedicatedly working along the objectives of this division. New work has been initiated in the following areas:

- **Development of a static National Biomass Atlas of India**

BEMD has developed a National Biomass Atlas for easier understanding of the from crop residual biomass availability scenario in the country, based on the study by ASCI for MNRE. The salient features of the National Biomass Atlas are:

- Graphically presents state-wise total and surplus biomass availability in the country.
- State-wise and Crop-wise surplus biomass availability for different important crops.
- State-wise and crop-wise fractions of the different residues available per crop for the various important crops.
- Images of the different crops considered with their crop residue ratios.

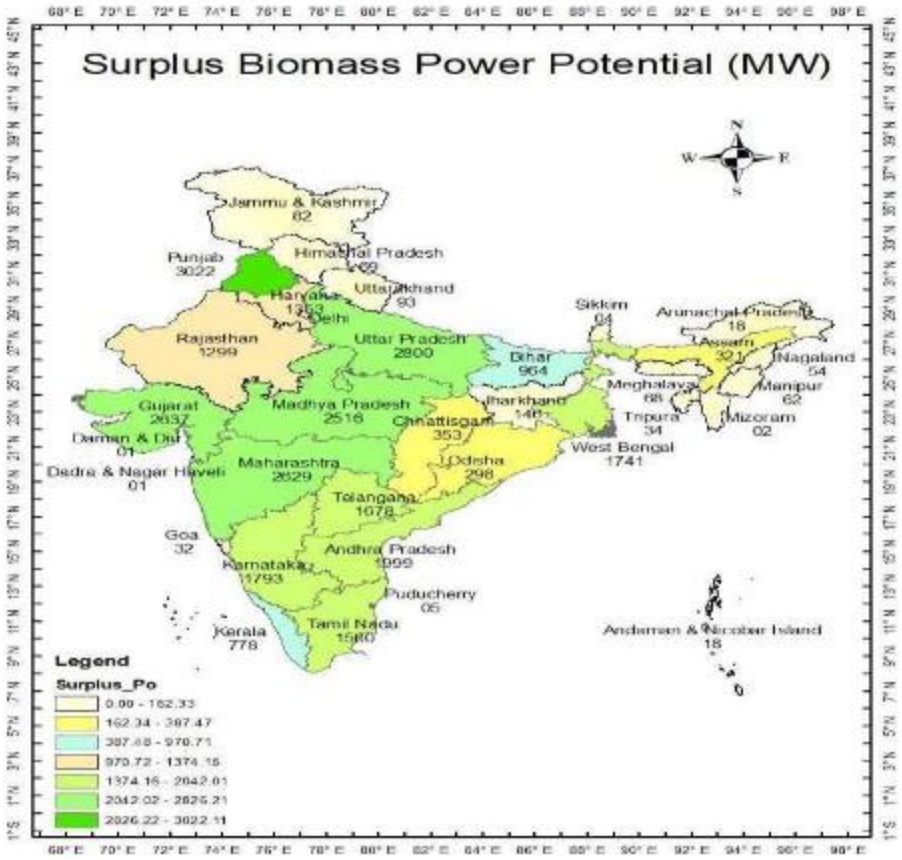


Fig. 10.45: National Biomass Atlas of India: Snapshots and URL

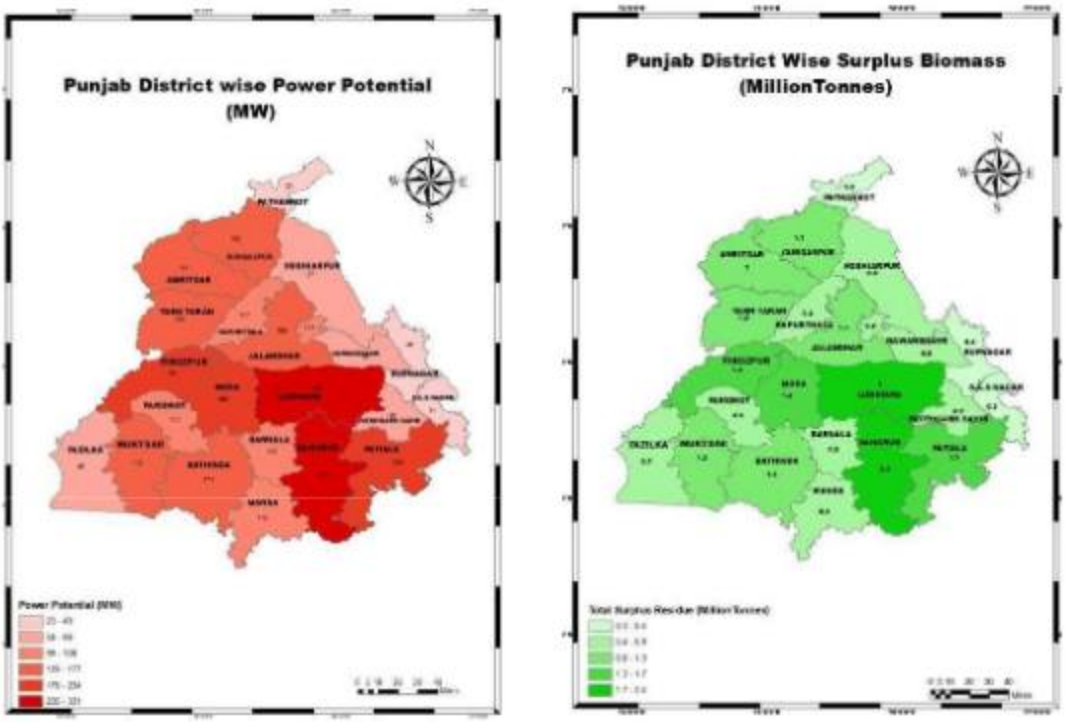


Fig. 10.46: District level Biomass Atlas of India

District level Biomass Atlas of India - graphically presents the District-wise Power Potential and Surplus Biomass availability. State of Punjab has around 22.87 million tonnes of Surplus biomass with 3.1 GW of Power Potential. The top three districts, Sangrur, Ludhiana, and Patiala, have the largest power potentials—331, 291 and 234 MW, respectively—from the available surplus biomass, which is 2.28, 2.0, and 1.62 million tonnes.

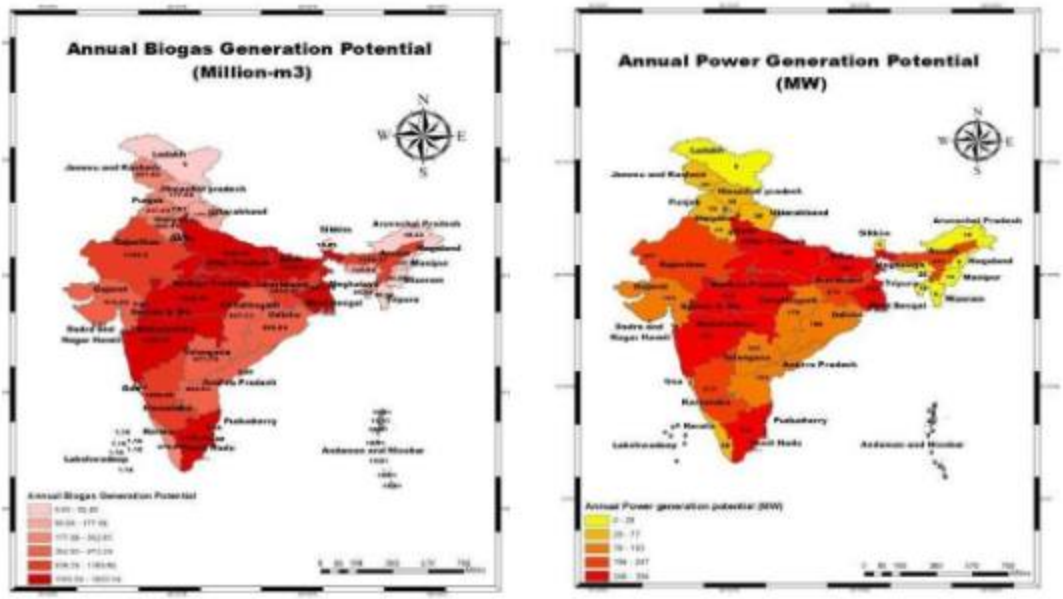


Fig. 10.47: National Livestock-waste Energy Atlas

Graphically represents the state-wise annual biogas generation potential and power generation potential based on the 20th Livestock Census, 2019

Considers three major livestock categories: (a) Cattle (b) Poultry (c) Piggery. The national livestock- based biogas generation potential is 20357 million m3 /year and annual power generation potential is 4.3 GW.

10.3.6. Collaborations

During the year 2023-24, SSS-NIBE signed MoU's with various institutions to facilitate collaborative research and exchange of students for academic work. The MoU's signed are:

1. MoU between SSS-NIBE and National Aerospace Laboratories (NAL) was signed on 29th November, 2023 with Surface Engineering Division of NAL, Bangalore for Joint R&D activities in the areas of application of biofuel in gaseous forms for power generation in high temperature fuel cell and work on Solid Oxide Fuel Cell (SoFC) for advancing its development in the country.



Fig. 10.48

2. **MoU between SSS-NIBE and IIM Amritsar** - An MoU was signed on 8th September, 2023 between SSS NIBE and IIM Amritsar for joint work on Biomass Supply Chain Management and other relevant areas that are critical for the techno-economic feasibility of the bioenergy sector
3. The extension of MoU between **SSS-NIBE and IBA, Gurugram** was signed on 09.01.2024.
4. A strategic MoU was signed between **SSS NIBE and Indian Institute of Technology, Roorkee** (IITR) on 09.02.2024. This MoU will explore several avenues for collaboration in the field of bioenergy and bioproducts, starting with research scholars enrolling for PhD programs at IITR, commencement of jointly new academic programs - integrated PhD,

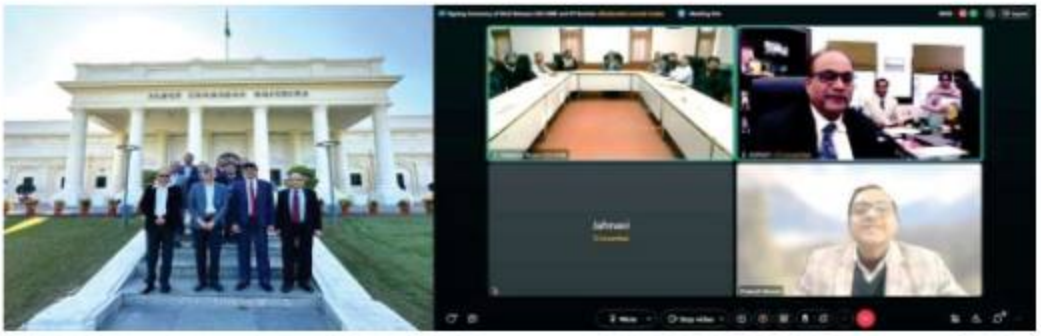


Fig. 10.48

10.3.7. Technology outreach and demonstration

SSS-NIBE exhibited a stall at the Biofuels Expo, Pragati Maidan, New Delhi from 5-7th June. The technologies/products developed at NIBE were showcased at the stall and generated a lot of interest in the expo visitors.



Fig. 10.50

10.3.8. Publications

During the year, following publications across various journals, conferences, books, etc. were brought out by scientists working in the Institute:

1. Kaur G, Basak N, Kumar S (2024) State-of-the-art techniques to enhance biomethane/biogas production in thermophilic anaerobic digestion. Process Safety and Environmental Protection, 186, 104-117. (IF 7.8)
2. Hans M, Pellegrini VO, Filgueiras JG, de Azevedo ER, Guimaraes FE, Chandel AK, Polikarpov I, Chadha BS, Kumar S (2023) Optimization of Dilute Acid Pretreatment for Enhanced Release of Fermentable Sugars from Sugarcane Bagasse and Validation by Biophysical Characterization. BioEnergy Research 16 (1), 416-434.(IF: 3.6)
3. Arora R, Singh P, Sarangi PK, Kumar S and Chandel AK (2023) A critical assessment on scalable technologies using high solids loadings in lignocellulose biorefinery: challenges and solutions. Critical Reviews in Biotechnology (In-press). (IF: 9.062)
4. Dhull P, Lohchab RK, Kumar S, Kumari M, Shaloo, Bhankhar AK (2023) Anaerobic Digestion: Advance Techniques for Enhanced Biomethane/Biogas Production as a Source of Renewable Energy. BioEnergy Research (In-press). https://doi.org/10.1007/s12155-023- 10621-7(IF: 3.6)
5. Hans M, Lugani Y, Chandel AK, Rai R, Kumar S (2023) Production of first- and second-generation ethanol for use in alcohol-based hand sanitizers and disinfectants in India. Biomass Conversion and Biorefinery 13(9), 7423-7440. (IF: 4.987)
6. Singh R, Hans M, Kumar S, Yadav YK (2023) Thermophilic Anaerobic Digestion: An Advancement towards Enhanced Biogas Production from Lignocellulosic Biomass. Sustainability 15(3), 1859. (IF: 3.889)
7. Behera, S, Sharma NK and Kumar S (2023) Augmentation of Bio-butanol Production Through Isolation, Screening and Optimization of Growth and Fermentation Parameters Using Response Surface Methodology. Sugar Tech 25, 531-541. (IF: 1.872)

8. Garg S, Behera S, Ruiz HA and Kumar S (2023) A Review on Opportunities and Limitations of Membrane Bioreactor Configuration in Biofuel Production. Applied Biochemistry and Biotechnology 195, 5497-5540. (IF: 3.094)
9. " Saranya, P., Jayanthi, S., & Nagappan, S. (2024). Production and characterization of extracellular laccase from Bacillus aerius SP3 and its application in dye decolorization. Biologia, 1-15.
10. Vandit Vijay, Santosh Saraswat (2023). From waste to wealth – biomass solutions (not only) for India's food loss challenge, Rural 21- The International Journal for Rural Development, 57 (4).
11. Vandit Vijay, Ram Chandra, Vivekanand Vivekanand, Anuj Kumar Chandel (2024). Editorial: The role of biochar in enhancing biogas productivity and bio-fertilizer quality, Frontiers in Energy Research, 12, 1357466.
12. https://doi.org/10.3389/fenrg.2024.13574
13. SK Saraswat, Vandit Vijay, G Sridhar (2023). National Biomass Atlas of India Brief (Biomass and Bioenergy Potential), OSF Preprints.
14. https://doi.org/10.31219/osf.io/dt68r
15. K Saraswat, Vandit Vijay (2023). Technical-Economic-Environmental (TE2) analysis of different site suitability classes in India, 5th International Conference on Energy, Power and Environment: Towards Flexible Green Energy Technologies (ICEPE), IEEE, 1-5.
16. Singh, G. N., Tyagi, U., Aslam, M., & Sarma, A. K. (2023). Expediency of Green Gasoline in Internal Combustion Engines. Green Gasoline: A Green Spark Transportation Fuel, 77, 218.
17. Singh, G. N., Sarma, A. K., Bharj, R. S.,Vandit Vijay(2023).A study on emission analysis of automotive diesel engine fired with 2nd generation ethanol-blends for clean environment. 4thInternational Conference on Recent Advances in Bio-Energy Research (ICRABR-2023).
18. Deepanshu Awasthi, Bhautik Gajera, Rakesh Godara, Arghya Datta, Nikhil Gakkhar, Tapas Kumar Patra. 2024. "Process Design of Various Biomass Gasification Processes Using Aspen Plus and Its Effects on Syngas and Hydrogen Production." CRC Press, 260-278
19. Awasthi, Deepanshu, Sujit Kumar Guchhait, Suman, Anil K. Sarma, and Bharat Bajaj. "Synthesis and application of Quintinite-3T nano catalyst along with KOH for biodiesel production from Jatrophacurcas oil and used cooking oil." Chemical Engineering Communications 211, no. 2 (2024): 263-274.
20. Guchhait, Sujit Kumar, and Anil Kumar Sarma. "Application of nanoemulsion in food and packaging industry." In Industrial Applications of Nanoemulsion, pp. 49-75. Elsevier, 2024.
21. Gajera, Bhautik, UplabdhiTyagi, Anil Kumar Sarma, and Mithilesh Kumar Jha. "Pyrolysis of cattle manure: Kinetics and thermodynamic analysis using TGA and artificial neural network." Biomass Conversion and Biorefinery (2023): 1-17.
22. Guchhait, Sujit Kumar, DebanjanSutradhar, Rajib Nandi, and Anil Kumar Sarma. "Biomass derived metal free hierarchical porous activated carbon for efficient oxygen evolution reaction." Energy Sources, Part A: Recovery, Utilization, and Environmental Effects 45, no. 2 (2023): 5957-5969.

23. MdAslam, S Maktedar, A K Sarma, Green Gasoline: A Green Spark Transportation Fuel, Royal Society of Chemistry, 2023, ISBN 978-1-83916-788-1.
24. J Kaur, U Tyagi, MdAsam, A K Sarma, Green Gasoline as a Commercial Liquid Fuel Throughout Asia, Europe and the USA: A Technical Review, Green Chemistry, RSC, https://doi.org/10.1039/BK9781837670079-00272
25. G N Singh, U Tyagi, MdAslam, A K Sarma, Expediency of Green Gasoline in Internal Combustion Engines, Green Chemistry, RSC, 218-237
26. U Tyagi, MdAslam, A K Sarma Transportation Biofuels: Green Gasoline, Bioethanol, Biodiesel and Green Diesel - A Comparison https://doi.org/10.1039/BK9781837670079-00196
27. U Tyagi, MdAslam, A K Sarma Green Anti-knock Agents for Enhancement of Gasoline Performance Green Chemistry. https://doi.org/10.1039/BK9781837670079-00238
28. P. R. Chauhan, G. Raveesh, K. Pal, R. Goyal, S. K. Tyagi. Production of biomass derived highly porous activated carbon: A solution towards in-situ burning of crop residues in India, Bioresource Technology Reports 22 (2023), https://doi.org/10.1016/j.biteb.2023.101425.
29. Hooda, D., Saraswat, S., Gakkhar, N. and Kumar, M., 2023. Assessment of Solar-Biomass Power Potential in the State of Punjab, India. Advances in Science and Technology, 130, pp.173-179.https://doi.org/10.4028/p-q0lbYI.

Book Chapters :

1. Kaur G, Umrao D, Dhull P, Kumar S (2024) The Role of Anaerobic Biorefinery in the Development of a Sustainable Economy. In: Chandel A (Ed.) Biorefinery and Industry 4.0: Empowering Sustainability. Springer, Cham, pp. 195-214.
2. Lugani Y, Brar SK, Kaur Y, Singh BP, Kumar D, Kumar S (2024) Sustainable production of advanced biofuel and platform chemicals from woody biomass. In: Deepak Kumar, Sachin Kumar, Karthik Rajendran (Eds.) Sustainable Biorefining of Woody Biomass to Biofuels and Biochemicals; Elsevier Woodhead Publishing, pp. 163-194.
3. Rao R, Dhull P, Shilpa, Kumar S, (2024) Recent Advances and Challenges in Biobutanol Production. In: Aslam M, Maktedar S, Sarma AK (Eds.) Green Gasoline: A Green Spark Transportation Fuel. RSC, London, pp. 109-123.
4. Sahni N, Hans M, Kumar S (2023) Fermentative Approaches in Wastewater Treatment for Harnessing Renewable Energy. In: Dheeran P, Kumar S (Eds.) Extremophiles: Wastewater and Algal Biorefinery; CRC Press, Boca Raton, pp. 60-79.
5. Suman, DeepanshuAwasthi, Nishtha, Nikhil Gakkhar, Bharat Bajaj; Role of Pretreatment Approaches to Generate Value-Added Products Using Agriculture Biomass; Valorization of Biomass Wastes for Environmental Sustainability: Green Practices for the Rural Circular Economy;Springer Nature Switzerland;pp133-152; dated - 2024/3/15.
6. DeepanshuAwasthi, BhautikGajera, RakeshGodara, ArghyaDatta, Nikhil Gakkhar, Tapas Kumar Patra; Process Design of Various Biomass Gasification Processes Using Aspen Plus and Its Effects on Syngas and Hydrogen Production; Biomass Energy for Sustainable Development; CRC Press; pp260-278; dated - 2024.

Books/ Conference Proceedings :

1. Kumar D, Kumar S, Rajendran K (Eds.) (2024). Sustainable Biorefining of Woody Biomass to Biofuels and Biochemicals. Elsevier Woodhead Publishing, Cambridge (ISBN978-0-323- 91187-0).
2. Gakkhar N, Kumar S, Sarma AK, Graham NT (Eds.) (2023) Recent Advances in Bio-Energy Research: Select Proceedings of the 3rd International Conference, ICRABR 2022. Springer Proceedings in Energy. Springer Nature Singapore (eBook ISBN 978-981-99-5758-3; Hardcover ISBN 978-981-99-5757-6).
3. Dheeran P, Kumar S (Eds.) (2023) Extremophiles: Wastewater and Algal Biorefinery; CRC Press, Boca Raton (eBook ISBN 978-1-003-33522-1; Hardcover ISBN 978-1-032-37080-4).

10.3.9. Patents

During the year, the institute published two patents in the field of biochemical conversion. The details of published patents are:

1. Sachin Kumar, Meenu Hans, Richa Singh, Nidhi Sahni and Pratibha Dheeran, Method of producing biogas from lignocellulosic biomass; (Application No.: TEMP/E-1/27176/2022- DEL(Ref. No.: 202211024777); Dated: 27.04.2022; Country: India). Published in the Patent Office Journal, issue no. 02/2024 dated 12/01/2024, Page No. 4187.
2. Sachin Kumar, Richa Arora, Nilesh K Sharma and Shuvashish Behera, Simultaneous Saccharification and Co-Fermentation of Paddy Straw for Bioethanol Production; (Application No.: 202211001560; Dated: 11.01.2022; Country: India). Published in the Patent Office Journal, issue no. 28/2023 dated 14/07/2023., Page No. 49277.

10.3.10. Events organized at the institute

National Technology Day was celebrated on 11th May, 2023. A lecture was delivered by Cdr Gurkeerat Sekhon (Retd) Executive Vice President - North Zone Punjab Renewable Energy Systems Pvt. Ltd.



Fig. 10.51

Various Life Mission awareness campaigns & events were organized by the institute under the #MeriLife initiative.



Fig. 10.52

Delighted to host Prof. K. K. Pant, Director, for the expert talk on "Hydrogen as a Fuel for Sustainable Environment: Role of Hydrogen Pathways for a Sustainable and Environment Friendly World"



Fig. 10.53

Special Guest Visit by Dr. Ajay Mathur, Director General, International Solar Alliance was organised. Dr. A. Mathur visited the Institute on June 2, 2023. He was warmly welcomed by DG NIBE and all the scientists. Thereafter, an introductory meeting with the scientific staff and research fellows was held. Dr. Ajay Mathur gave a presentation on biomass-solar hybrid H2 generation followed by a discussion session.



Fig. 10.54



Fig. 10.55: International Yoga Day (21st June 2023)



Fig. 10.56: Glimpse of 77th Independence Day Celebrated in SSS NIBE

4th International Conference on Recent Advances in Bio-energy Research (ICRABR-2023)

SSS NIBE organized the ICRABR-2023 during 9th - 12th October 2023. The conference was envisioned to serve as a holistic learning event and congregation of all the stakeholders in the bioenergy sector and diverse participation of over 250 national and international participants was received from all stakeholders in the bioenergy sector including the policy-makers, government, industry, UN agencies, academia. During the event, Sh. Bhupinder Singh Bhalla (IAS), Secretary, Ministry of New and Renewable Energy (MNRE), highlighted the importance of bioenergy to meet rapidly increasing energy demand in future and also informed participants about the vital support that the MNRE is providing for the sector. Sh. Bhagwanth Khuba, Hon'ble Minister of State (MNRE, Chemicals and Fertilizers) delivered his message for the conference with a pre-recorded video. Sh. Bhalla also launched a communication kit with information material on the Ministry's schemes for better outreach of the National Bioenergy Programme and flagged off mobile vans that would go around different districts in the state of Punjab to spread awareness about the ill effects of stubble burning of biomass majorly paddy straw, and instead use it for various Bioenergy Projects under the National Bioenergy Programme. Director General NIBE, Dr G Sridhar highlighted the relevance of bioenergy for the country to achieve energy self-dependence and NIBE's efforts towards these goals. Prof K K Pant, Director IIT Roorkee, talked about the role of research and innovations required for a holistic and sustainable bio-based economy.

The conference witnessed plenary lectures from distinguished scientists of the country and abroad on biohydrogen, bio-refinery, biomass resource management, waste to energy etc. The delegates also got a glimpse of some of the advances in bioenergy from the exhibit stalls from reputed industries and institutions and an industrial exposure visit to an 18 MW biomass-to-power plant in Punjab.



Fig. 10.57: Glimpses from ICRABR 2023 Inaugural ceremony and field visit



कपूरथला फगवाड़ा 10-10-2023

सरदार स्वर्ण सिंह संस्थान में जैव-ऊर्जा अनुसंधान में मौजूदा तरक्की विषय पर सम्मेलन शुरू

ਸੈਂਟ ਉਰਜਾ ਖੇਤ ਵਿੱਚ ਮੌਜੂਦਾ ਤਰੱਕੀ' ਦੇ ਵਿਸ਼ੇ 'ਤੇ ਚੌਥੀ ਅੰਤਰਰਾਸ਼ਟਰੀ ਕਾਨਫ਼ਰੰਸ ਦੀ ਹੋਈ ਸ਼ੁਰੂਆਤ

October 09, 2023

ਅਜਰਬਾਰ ਦੀਆਂ 24 ਖਿਲੂਰ)

Fig. 10.58: Glimpses from ICRABR 2023 - Media Coverage

Training/Workshop Program

SSS NIBE is devoted to the promotion of bio-energy, with this aim, the institution organised outreach programmes and events on many facets of bio-energy. In 2023-24, the institute organised the following capacity building programs.

- National Hands-on training program on Bio-Gas Technology and its implementations
- National Workshop on Biomass-based Clean Cooking Solutions

SSS-NIBE and Indian Biogas Association (IBA) jointly organized a five-day National hands-on training program on 'Biogas Technology and its Implementation' in hybrid mode between 19 and 23 Feb 2024. The event was inaugurated on 19th Feb by Dr. G. Sridhar, Director General, SSS-NIBE, with Dr. AR Shukla, President, IBA as the Chief Guest and Sh. Gaurav Kedia, Chairman, IBA as the Guest of Honor.



Fig. 10.59

Similarly, a two days National Workshop on, Biomass-based Clean Cooking Solutions was organized from 29th Feb. to 1st March, 2024. The event was inaugurated on 29th Feb by Dr. G. Sridhar - Director General, SSS-NIBE, Chief Guest - Dr. Jatinder Kaur Arora, Executive Director, PSCST, Guest of Honour - Dr. Sangita M Kasture, Adviser & Scientist G, MNRE.



Fig. 10.60

Hindi Pakhwada

During the Hindi Fortnight celebration, the institute organized various competitions and a Kavi Sammelan. Prominent among these competitions were the Hindi essay competition, quiz competition, and debate competition, all of which saw active participation from institute employees. The Kavi Sammelan featured participation of esteemed poets, Mr. Rajesh Chetan and Mrs. Baljeet Kaur, who have presented their works on both national and international platforms.

Vigilance Awareness Week

In accordance with the directives of the Central Vigilance Commission (CVC), SSS-NIBE observed the "Vigilance Awareness Week" from 30.10.2023 to 05.11.2023. As part of the observance, several events including an integrity pledge, debate, quiz competition, and a guest lecture from Mr. Inder Raj Singh Bains (retd.) P.C.S. Officer from the Cooperative Department, Government of Punjab were organised at SSS-NIBE.

Inauguration of Innovation and Computational facility

On 02/11/2023, DG, SSS-NIBE inaugurated the Innovation and Computational Centre located at the Technical Block, SSS-NIBE. This state-of-the-art facility is designed to support advanced computational work and serve as a collaborative environment, fostering interactions among staff, students, and organizations.

Constitution Day Celebration

The Institute celebrated the Constitution Day with pride on 26.11.2023 at auditorium. During the event, staff and research fellows led by Director General took a pledge to uphold the values that shape our democracy.



Fig. 10.61

75th Republic Day Celebration

The 75th Republic Day was celebrated on 26th January, 2024 with enthusiasm in the Institute. On this occasion, DG NIBE hoisted the flag. The flag hoisting was followed by tree plantation from DG NIBE. A brief cultural program was conducted by research fellows, staff and their families.

10.4 SOLAR ENERGY CORPORATION OF INDIA LIMITED (SECI)

10.4.1 INTRODUCTION

Solar Energy Corporation of India Ltd. (SECI) is a Section- 3 Company under the Companies Act, 2013, with 100 percent Government of India ownership, under the administrative control of the Ministry of New and Renewable Energy (MNRE). SECI is a Schedule- A Central Public Sector Undertaking (CPSU). SECI was accorded the status of Miniratna Category-I Central Public Sector Enterprise (CPSE) on 10.04.2023. The company is an implementing and executing arm of Govt. of India for development of Renewable Energy (RE) sector in the country.

10.4.2 BUSINESS ACTVITIES

10.4.2.1 Tenders for Large-scale Solar projects

SECI brings out tenders for setting up of large-scale Wind Power Projects on Pan-India basis in developer-mode, towards fulfilment of National target.

Cumulative awarded wind capacity by SECI is 16.271 GW (till 31.03.2024), of which, 1.84 GW has been awarded during FY 2023-24. Of the total awarded capacity 6.008 GW has been commissioned (till 31.03.2024).

10.4.2.3 Tenders for Hybrid Projects

To cater to offtakers' demand for bringing firmness and flexibility in RE power, SECI has issued tenders with different configurations, viz. Solar-Wind Hybrid, RE with assured supply during peak hours and Round the Clock (RTC) RE, with provision for combination of different RE/energy technologies and/or energy storage, as applicable.

Cumulative awarded capacity in this segment is 8.87 GW (till 31.03.2024), of which 2.1 GW was awarded in FY 2023-24. Of the total awarded hybrid capacity, 1.44 GW hybrid capacity have been commissioned till 31.03.2024.

In response to the growing share of RE and to better integrate the RE capacities into the National Grid, the company has been at the forefront of innovation. In FY 2023-24, SECI issued tenders which provide Firm and Dispatchable RE (FDRE) to DISCOMs. FDRE ensures that energy buyers receive power tailored to their needs, these models signify a pivotal shift in the dynamics between energy buyers and suppliers. They must adhere to pre-defined demand schedules provided by buyers, with penalties imposed for any shortfalls in meeting these requirements as per tender conditions.

10.4.2.4 Grid Connected Roof-Top Programme

SECI has played a pivotal role in promoting Rooftop Solar through competitive bidding route in the country under various schemes of MNRE.

SECI came out with a tender for Setting up of Grid-Connected Rooftop Solar PV Projects on Government buildings under Ministry of Home Affairs. Under this tender 16.48 MW of capacity was awarded in June 2023.

10.4.2.5 Other Schemes of MNRE for promotion of RE

SECI is also implementing MNRE schemes with the role of disbursement of Central Financial Assistance (CFA) to the implementing agencies based on pre-determined progress milestones. Ongoing schemes are: (a) Solar Parks Scheme; (b) Scheme for Defence Establishments; (c) VGF Scheme; (d) CPSU Scheme

The company has six joint venture companies with states -Andhra Pradesh, Karnataka, Uttar Pradesh, Madhya Pradesh, Kerala and Himachal Pradesh-these have been set up primarily to set up large scale Solar Parks and related infrastructure.

PLI (Tranche-II) scheme for module manufacturing: Under MNRE's PLI (Tranche II) scheme for module manufacturing, SECI was designated as the nodal agency. Under this, LoAs were issued to 11 successful Bidders in April 2023. As per LoA, the Total Manufacturing Capacity is 39.6 GW with a PLI allocation of Rs 13,937.57 Cr.

10.4.2.6 Project Development

SECI develops RE projects through its own investment and offers Project Management Consultancy Services to other Govt. Agencies/PSUs for RE projects.

Operational CAPEX Projects:

- 100 MW Solar with Battery Storage in Rajnandgaon Chhattisgarh.
- 10 MW Solar Project in Badi Sid, Jodhpur district of Rajasthan.
- 10 MW Solar Project in DRDO Kolar in Karnataka.
- 1.7 MW solar with Battery Storage project in Lakshadweep Islands.
- 1 MW Rooftop Solar project in Andaman & Nicobar Islands.

Ongoing/Upcoming CAPEX Projects:

- 100 MW Floating Solar project in Getalsud reservoir, Ranchi in Jharkhand, under award finalisation.
- 1200 MW capacity of solar projects has been allotted to SECI under MNRE's CPSU scheme Ph-II, Tranche- III. The projects are under various stages of pre-tendering and tendering phase.

10.4.2.7 13 GW RE project in Ladakh

SECI had identified the land for setting up the 13 GW Ultra Mega RE project in Pang-Debring-Kharnak in Leh, Ladakh. This project will also have BESS component. Total land area of 48,000 acres has been identified, Revenue Department, UT Administration has given in-principle approval for allocation of land. Currently various studies/assessments are being carried out.

10.4.2.8 Power Trading

SECI is the intermediary power procurer between developers and offtakers for Solar Wind, Hybrid projects set up through SECI tenders. SECI has a Category I Trading License from Central Electricity Regulatory Commission (CERC) to carry out power trading on pan-India basis. SECI has signed Power Sale Agreements (PSAs) of 52.398 GW capacity (cumulative, till 31.03.2024). SECI has traded 42.935 Billion Units of renewable energy in FY 2032-24, this is a growth of 22 % from the previous year.

10.4.2.9 New Initiatives

To align with the rapidly evolving renewable energy (RE) sector, SECI is venturing into new business areas, including Green Hydrogen, Greening the Transport Sector, Energy Storage, Market-Based Models for Supply of RE, among others. In doing so, SECI is actively collaborating with relevant stakeholders to explore and tap into the potential of these emerging opportunities.

Green Hydrogen: SECI is preparing to become the primary aggregator in the green hydrogen sector, with its implementation plans already in progress. SECI has already awarded tenders under Tranche-I of the incentive schemes under MNRE's Strategic Interventions for Green Hydrogen Transition (SIGHT) scheme.

Supply of Green Power in Transport Sector: The transport sector offers huge potential for transition to Clean Energy sources, especially through Electric Vehicles. SECI has entered into MOU with NCRTC & BPCL for Greening of the Transportation sector.

Energy Storage: The integration of energy storage systems into the Indian Power sector is essential to enhance the utilization of renewable energy infrastructure. With this aim SECI has issued various tenders with provisions for setting up of energy storage systems both on standalone and integrated basis.

Development of Market-Based Models for Supply of RE: SECI is exploring development of market-based models for supply of RE power that is under deliberation by concerned stakeholders.

10.4.2.10 Financial Performance

Highlights of Financial performance for fiscal year 2023-24, with comparative position of the previous year, are mentioned below-

			Rs. Cr.
Particulars	FY 2023-24 (Prov.)	FY 2022-23 (for comparative reference)	% Increase in FY 2023-24 over FY 2022-23
Net Worth	2,811.76	2376.31	18.32%
Total Revenue	13,135.80	10,864.43	20.91%
Profit Before Tax	584.45	423.6	37.97%
Profit After Tax	436.03	315.65	38.13%

10.5 INDIAN RENEWABLE ENERGY DEVELOPMENT AGENCY LIMITED (IREDA)

10.5.1 Indian Renewable Energy Development Agency Limited (IREDA) is a Navratna Central Public Sector Enterprise (CPSE) under the administrative control of Ministry of New and Renewable Energy (MNRE). IREDA is a Public Limited Government Company established as a Non-Banking Financial Institution in 1987 engaged in promoting, developing and extending financial assistance for setting up projects relating to new and renewable sources of energy and energy efficiency / conservation, with the motto: ENERGY FOR EVER.

10.5.2 FINANCIAL & OPERATIONAL PERFORMANCE

(i) During the Financial Year 2023-24, IREDA has achieved highest-ever loan sanctions of ₹ 37,353.68 Crore, thereby registering an increase of 14.63% over the previous year's sanctions of ₹32,586.60 Crore and highest ever loan disbursements of ₹ 25,089.04 Crore with a growth of 15.94% over the previous year's disbursement of ₹ 21,639.21 Crore.

The revenue from operations increased to ₹ 4,963.94 Crore, registering a growth of 42.56% over the previous year's revenue of ₹ 3,481.97 Crore. Profit Before Tax (PBT) and Profit After Tax (PAT) increased to an all-time high of ₹ 1,685.24 Crore (47.93% increase over last year) and ₹ 1,252.23 (44.83% increase over last year) respectively at the end of FY 24. The loan book of the Company has grown from ₹ 47,075.52 Crore as on 31st March, 2023 to ₹ 59,698.11 Crore as on 31st March, 2024 registering a growth of 26.81%.

(ii) The loans sanctioned during Financial Year 2023-24 (includes co-financed projects / takeover loans) would support power generation capacity addition of 2,526.19 MW, RE Equipment Manufacturing of 14,284.00 MWp per annum, Biofuel Ethanol production of 3,895 KLPD, Biomass (CBG) 55.10 TPD, Waste to Energy (Biogas from waste) 9.40 TPD and Green Ammonia 900 MTPD. The sector wise breakup of sanctions and disbursements for the Financial Year 2023-24 and the cumulative achievements as on 31.03.2024 are given below in **Table 10.8 and Table 10.9.**

Table 10.8: IREDA Sector-Wise Break-up of Loan Sanctions and Disbursements During FY 2023-24

(in Crore)

Sector	Sanctions	Disbursements (including previous year sanctions)
Solar Power	6,065.30	5,879.35
Wind Power	2,096.83	3,020.59
Hydro Power	1,419.89	2,660.78
Manufacturing	6,754.48	2,404.49
Hybrid Wind & Solar	1,634.02	140.00
Ethanol	3,901.60	2,017.86
Electrical Vehicle	1,062.44	593.39
Short Term Loan	1,884.50	918.73
Biomass	412.24	112.64
Biomass Power & Cogeneration	103.00	98.41
Waste to Energy	102.70	85.63
State Utilities - Genco	1,000.00	1,000.00
State Utilities - Discoms & others	6,200.00	5,200.00
Miscellaneous (Transmission / Emerging Technology)	4,716.68	957.17
TOTAL	**37,353.68**	**25,089.04**

Table 10.9: IREDA - Sector-Wise Break-up of Cumulative Loan Sanctions and Disbursements as on 31.03.2024

(in Crore)

Sector	Cumulative Sanctions	Cumulative Disbursements
Wind Power	36,693.59	26,913.24
Hydro Power	17,151.41	11,231.91
Biomass Power & Cogeneration	5,640.38	3,591.65
Energy Efficiency & Conservation	1,381.71	441.54
Solar Energy	49,964.68	31,546.56
Waste to Energy	1,144.93	683.10
National Clean Energy Fund (NCEF)	156.57	127.14
Bill Discounting	181.97	161.76
Bridge Loan	223.86	152.90
Short Term Loan	12,107.83	7,079.43
Electrical Vehicle (EV)	1,632.80	961.12
Biomass (Briquetting, Gasification & Methanation from Industrial Effluents)	634.43	266.98
Guaranteed Emergency Credit Line (GECL)	565.10	539.84
Loan Facility to State Utilities	33,412.00	31,895.00
Hybrid Wind & Solar	3,285.49	1,234.78
Ethanol	7,176.05	3,559.62
Manufacturing	10,783.97	4,191.63
Miscellaneous (Transmission Lines, Emerging Technology, Guarantee Assistance	8,325.76	1,338.47
TOTAL	**190,462.53**	**125,916.67**

10.5.3 MOU WITH MNRE

IREDA has signed a Memorandum of Understanding (MoU) with the Ministry of New and Renewable Energy (MNRE), Government of India setting key targets for the Financial Year 2023-24 and 2024-25.

The performance of the Company for the financial year 2022-23 has been rated as "Excellent" by DPE. For FY 24, the Company is expecting to achieve "Excellent" rating subject to assessment by GoI.

10.5.4 MoU FOR GREEN ENERGY COLLABORATIONS

During the Financial Year 2023-24, IREDA has entered into Memorandum of Understanding (MoUs) with IIFCL, Bank of Maharashtra, Union Bank of India, Bank of Baroda and Indian Overseas Bank. These collaborations aimed at promoting and facilitating co-lending and loan syndication for a diverse spectrum of Renewable Energy projects across the nation. Apart form the above, IREDA and AIIMS signed a MoU to initiate the technical assessment of AIIMS, New Delhi campus for solarization.

10.5.5 RESOURCE BASE

The total borrowings of IREDA stood at ₹ 49,686.86 Crore as on March 31, 2024 as against ₹ 40,165.28 Crore in the previous year. During the Financial Year 2023- 24, IREDA has mobilized ₹16,401.18 Crore from domestic as well as international sources.

Net Worth of the Company increased to ₹ 8,559.43 Crore at the end of the Financial Year 2023-24, registering an increase of 44.22 % over the previous year's Net Worth of ₹ 5,935.17 Crore. The authorized and paid-up capital of IREDA stood at ₹ 6,000 crore and ₹ 2,687.76 respectively at the end of Financial Year 2023-24.

10.5.6 Initial Public Offer (IPO)

Initial Public Offer (IPO) of IREDA got successfully completed by issuance of 67.19 crore equity shares of face value of ₹10 each at a price of ₹ 32 per equity share (including a premium of ₹ 22 per equity share). The public subscription opened on 21st November, 2023 and closed on 23rd November, 2023. The IPO proceeds of ₹ 2,150.21 crore, comprises a fresh issue of 40.32 crore equity shares aggregating to ₹ 1290.13 crore by IREDA and an offer for sale (OFS) of 26.87 crore equity shares aggregating to ₹ 860.08 crore by the President of India, acting through the Ministry of New and Renewable Energy.

The IPO received overwhelming response from the investors. The issue was overall subscribed a strong 38.80 times during the three-day bidding process. The portion for qualified institutional bidders (QIBs) witnessed a massive 104.57 times subscription, while the portion reserved for non-institutional investors saw 24.16 times bidding. The shares of the company got listed on both NSE and BSE on 29th November 2023 with listing price at approx. 56% hike in the pre-open trading debut. Post the IPO the stake of Government of India in IREDA stands at 75% of our post-offer paid-up equity share capital. The IPO proceeds shall be utilized by the company for capital augmentation and on-lending.

10.5.7 MNRE SCHEMES

IREDA is the Implementing Agency for the four MNRE Scheme / Programmes, namely:

- Central Public Sector Undertaking (CPSU) Scheme - Phase-II (Government Producer Scheme)
- National Programme on High-Efficiency Solar PV Modules under Production Linked Incentive (PLI) Scheme (Tranche -1)
- National Bioenergy Programme
- Generation Based Incentive Schemes

10.5.8 HUMAN RESOURCE DEVELOPMENT

The high-performance culture of IREDA is driven by its highly motivated and skilled manpower. To optimize the potential of its human capital, the Company has provided specialized training programs from various premium institutes / organizations in India and abroad, besides in-house training sessions for the employees. The employees are kept updated with the latest developments in their relevant fields. Customized virtual in-house programmes, masterclasses on new and emerging technologies along with other need-based programmes were organized.

A safe and inclusive work environment is maintained, wherein employees can grow both professionally and personally. Yoga and Meditation sessions are being conducted on daily basis. The company organized preventive health check-up for its employees, under the aegis of "Azadi Ka Amrit Mahotsav". IREDA celebrated International Yoga Day, Azadi Ka Amrit Mahatosav, Vigilance Awareness Week, Hindi Pakhwada and Women's Day during the year.
IREDA observes the reservation policy of the Government of India as applicable in the categories belonging to Scheduled Castes / Scheduled Tribes / Other Backward Communities/ Person with Disabilities & EWS. IREDA is following the reservation rosters prescribed by the Government. Employee relations continued to be very cordial and harmonious during the financial year. There were no man-days lost during the period under review. IREDA provides equal growth opportunities for the women in line with Government of India philosophy on the subject. The Company has Women employees in important and critical functional areas across hierarchical levels. The women are well represented and constitute 26.29% of the total work force.
As on 31.03.2024, the Company has 175 full time employees comprising of 159 Executives (including 02 Board Level Executives) and 16 Non-Executives.

10.5.9 CORPORATE SOCIAL RESPONSIBILITY / SUSTAINABLE DEVELOPMENT

IREDA is committed to be a socially responsible organization that actively contributes to society to improve the quality of life. Through CSR initiatives, IREDA aims to address community development and empower individuals through education, healthcare and sanitation. In addition, the Company focus on environmental protection, promotion of green and energy-efficiency technologies and development underprivileged regions.
For the Financial Year 2023-24, a CSR Budget of 1693.52 Lakhs was available. As on 31st March 2024, total amount of 1661.82 lakhs has been sanctioned apart from set-off of an amount of Rs. 28.93 Lakh spent in access during the previous year and administrative overheads of Rs. 2.76 Lakh., ensuring complete sanctioning of the entire CSR obligation for the FY 2023-24.

During the Financial Year 2023-24, following activities / projects were undertaken by the Company under its CSR initiatives as shown in **Table 10.10.**

Table 10.10: CSR Initiatives undertaken by IREDA during the year 2023 - 24 (1st April, 2023 to 31th March, 2024)

S. No.	Description	₹ / Lakhs
1	Financial assistance for Procurement and installation of the following equipment in Aspirational District- Chandauli, Uttar Pradesh: • 83 units of 5 kW Solar PV systems (off-grid) and 90 units of 50 LPH RO water vending Machines to be installed in Government Health Centers/ Hospitals; • 1 unit of 3 kW Solar PV systems (off-grid) along with a 50 LPH RO water vending Machine to be installed in Jawahar Navodaya Vidyalaya, Bairath.	384.57
2	Financial assistance for supplying medical equipment in Govt. Hospitals, Desk Bench in Govt. Schools, Beds, Tables and Chairs in Govt. Girls Hostel in Balrampur Aspirational District, Uttar Pradesh	287.05

S. No.	Description	₹ / Lakhs
3	Financial assistance for conducting ten (10) Health, Sanitation & Hygiene Awareness Camps for children/ students in Lucknow, Uttar Pradesh	16.02
4	Financial assistance for procurement and installation of 200 kWp Solar PV Rooftop Grid Connected System at Jayadev Memorial Rashtrotthana Hospital of Rashtrotthana Trust in Bengaluru, Karnataka	80.00
5	Financial assistance for imparting Emergency Response Training to 5200 beneficiaries by M/ s Aim Achievers Education Society in Bhopal, Madhya Pradesh	25.00
6	Financial assistance for providing Healthcare to 325 Nos. Beneficiaries i.e. Women/Girls in Rural areas of Khekra Block in Baghpat and Loni Block in Ghaziabad District (U.P.) by M/s The Golden Village Foundation, Baghpat, Uttar Pradesh	30.85
7	Financial assistance for Solar based irrigation systems and other agricultural practices to reduce distress migration in three (03) tribal Villages, Block-Mandvi, District-Surat, State Gujarat	141.83
8	Financial assistance for supply & installation of Solar Streetlights in villages of the GPs & supply of Solar Power systems, furniture & other educational materials in schools of both Gram Panchayats of Aspirational District of Kalahandi, Odisha.	28.52
9	Financial assistance for carrying out installation of Solar Street Lighting systems in 42 villages of Machilipatnam Parliamentary Constituency, Machilipatnam, Krishna District, Andhra Pradesh	59.94
10	Financial assistancefor carrying out installation of 1000 Nos. Solar Street Lighting systems in Siddharthnagar Parliamentary Constituency, Aspirational District Siddharthnagar, Uttar Pradesh	189.56
11	Financial Assistance for ease of transit of Senior Citizens & Physically Challenged Persons visiting the heritage city of Puri along with different tourist spots by donating 5 no. of BOVs (6 Seated) & 5 no. of BOVs (11 Seated) to Shree Jagannath Temple Administration, Puri	66.13
12	Financial assistance for supply & installation of Solar LED Street Lights in 33 villages within the two blocks of Bisoi and Saraskana along with Govt. ITI Karanjia, Mandua Campus within Mayurbhanj District Odisha	25.94
13	Financial assistance for providing health care facilities via deployment of e-Mobile Health Clinics across 9 blocks under the District Buxar - Bihar	32.40
14	Financial assistance for supply and installation of Solar PV Systems in Govt. Schools / Hostels and Govt Health Centers in Balrampur Aspirational District, Uttar Pradesh	146.42
15	Operational expenses of two Mobile Medical Van running the "Therapy on Wheels" Program by Samphia Foundation, in Himachal Pradesh for serving Children with Disabilities	47.58

S. No.	Description	₹ / Lakhs
16	Sanction of one-time contribution for "PARAM PROJECT: Science, Technology & Innovation Skill Development Centre' in FY 2023- 24 to Janaseva Trust, Channenahalli, Bengaluru, Karnataka	100.00
	Amount spent in administrative overheads:	2.76
	Total Sanctioned Amount during the year 2023-24	**1664.58**

10.5.10 Awards

- CMD, IREDA has been bestowed with the esteemed "CMD of the Year" award consecutively for the 2nd year under the Mini-Ratna category at the 13th PSE Excellence Awards, hosted by the Indian Chamber of Commerce in New Delhi on 20.12.2023.
- IREDA also emerged as a runner-up in four key categories: "Operational Performance Excellence", "Corporate Governance," "Corporate Social Responsibility & Sustainability," and "Inclusivity- Contribution of Women and Differently-Abled."

CHAPTER 11

SUPPORT PROGRAMMES

11.1 INFORMATION AND PUBLIC AWARENESS PROGRAMME

11.1.1 India stands 4th globally in terms of renewable energy installed capacity including large hydro. The Ministry has worked systematically for putting inplace facilitative policies and programmes for achieving the goal. In order to percolate the initiatives, benefits and usage of renewable to the masses, information dissemination and publicity is essential. In this background, I&PA programmes for renewable energy are conceptualized and developed for implementation.

11.1.2 To strengthen the existing programme in the changing scenario of information age in order to make it more efficient and cost effective, which include need to showcase itself on the new social media platforms including Facebook, Instagram, LinkedIn, YouTube, etc., a Social Media Cell has been set up in the Ministry.

11.1.3 11.1.3 The Programme is implemented using Government channels viz. (i) Central Bureau of Communication (CBC) (ii) National Film Development Corporation (NFDC); (iii) Doordarshan; (iv) All India Radio (AIR);
(v) State Nodal Departments/Agencies for renewable energy; and (vi) NGOs/ Academic institution, etc., and participation in exhibitions of national importance by the Ministry and also through other relevant Institutions/Organizations. It is also providing information and awareness through its three autonomous Institutions i.e. NISE, NIWE and SSS-NIBE and two PSUs i.e. IREDA and SECI extensively. During the year, following I&PA activities were developed and implemented under the overall framework of the media strategy for renewables:

i) Several events such as webinar, workshop on the Ministry's programmes, schemes, achievements and future plans etc. were organized under AzadiKaAmritMahotsav and posted on social media platforms and also uploaded on the nodal Ministry's portal i.e. Ministry of Culture.

ii) Logo Support of the Ministry was extended to different events/exhibitions on Renewable Energy.

11.2 HUMAN RESOURCE DEVELOPMENT

11.2.1 Human Resource Development (HRD) Programme of MNRE aims to institutionalize the renewable energy education and training to meet the requirement of qualified and trained manpower in the country. HRD Programme supports trainings for manpower at all levels including promoting higher studies and research courses by providing Fellowships to students and research scholars in R&D and academic institutions in Renewable Energy. Support is also provided to R&D and academic institutes for up-gradation of their laboratories for conducting higher degree courses at the Post-Graduate and Doctoral levels in New and Renewable Energy. Under short term training programmes of HRD scheme, Skill Development Programmes namely Suryamitra, Varunmitra, Vayumitra and Jalurjamitra were launched to train workforce for installation, commissioning, operation and maintenance of renewable energy projects.
Various components of the HRD scheme are as follows:

a) Support to educational and other training organizations for conducting short-term trainings on various aspects of Renewable Energy with focus on skill development at all levels. Skill development programmes such as Solar PV Technician (Suryamitra), Solar Water Pumping Technician (Varunmitra) Wind Power Plant Technician (Vayumitra) and Small Hydro Power Plant Technician (Jalurjamitra).

b) National Renewable Energy Fellowship (NREF) Scheme for pursuing M.Sc./M.Tech/ PhD/ PDF degree courses.

c) National Renewable Energy Science Fellowship Scheme for eminent scientists working in research institutes with an innovative idea in renewable energy.

d) Support to higher educational institutions for laboratory upgradation.

e) National Renewable Energy Internship scheme (NREI).

f) Renewable Energy Chair.

11.2.2 National Renewable Energy Fellowship Scheme

MNRE continued its support to students and scholars for pursuing higher studies such as M.Sc, M.Tech, Ph.D courses in Renewable Energy through ongoing fellowships in 10 selected educational institutions by providing fellowships or stipend under NREF Scheme. Ministry also continued support to 55 No. of ongoing fellowships. The details of institutions supported by MNRE for ongoing fellowships under NREF scheme in 2023-24 are given below in Table 11.1

Table 11.1 : Institutions supported by MNRE for ongoing fellowships under NREF programme in 2023-24

S. No.	Institutions to which Fellowships provided [M. Sc, M.Tech, JRF/SRF (Ph.D)]
1	Indian Institute of Technology, Kharagpur
2	Indian Institute of Technology, Roorkee
3	Pune University, Pune, Maharashtra.
4	Pondicherry University, Puducherry.
5	Cochin University of Science and Technology, Kochi
6	Indian Institute of Engineering Science & Technology, Shibpur, West Bengal.
7	National Physical Laboratory (NPL), CSIR, New Delhi
8	National Institute of Bio-Energy, Kapurthala - National Institute of Technology, Jalandhar
9	Sri Mata Vaishno Devi University, Katra
10	Department of Applied Science & Humanities, Jamia Milia Islamia University
11	Department of Energy, Tezpur University

11.2.3 Skill Development Programmes and Trainings

(a) Solar PV Technician (Suryamitra Skill Development) Programme

Solar PV Technician (Suryamitra) training was initiated by the Ministry in 2015 to develop work force to meet the demand of solar energy sector. In Financial Year 2023-24 4858 no. of Suryamitras were trained and training of 850 no. of Suryamitras is undergoing. These training programmes are being organized through Training Centres and partner organizations in different states across the country empanelled through a transparent process by NISE. A cumulative 56507 nos. of Suryamitras have been trained as on March, 2024. The state-wise progress of the Suryamitra programme from FY 2015-16 to 2023-24 is shown in Table 11.2.

Table 11.2 : Progress of Number of Suryamitras trained in different States 2015-16 to 2023-2024 (31st March, 2024)

S. No.	State/UTs	No. of Suryamitras trained								
		2015 -16	2016 -17	2017 -18	2018 -19	2019 -20	2020-21	2021-22	2022-23	Total
1	Andhra Pradesh	235	398	211	464	488	219	120	60	2195
2	Arunachal Pradesh	30	0	0	0	0	0	30	0	60
3	Assam (NER)	30	151	252	400	561	148	90	0	1632
4	Bihar	30	402	287	420	568	179	0	0	1886
5	Chandigarh (UT)	0	0	58	90	90	0	30	0	268
6	Chhattisgarh	90	369	408	360	778	204	28	30	2267
7	Delhi (UT)	50	0	181	201	240	30	0	0	702
8	Goa	30	30	54	60	117	30	0	0	321
9	Gujarat	297	954	335	550	856	261	60	84	3397
10	Haryana	52	121	374	390	480	86	58	30	1591
11	Himachal Pradesh	0	36	138	150	120	30	30	30	534
12	Jammu and Kashmir (UT)	26	0	60	158	306	146	60	30	786
13	Jharkhand	0	152	185	180	269	60	30	0	876
14	Karnataka	90	420	513	348	363	79	90	60	1963
15	Kerala	57	176	120	142	240	90	60	60	945
16	Ladakh (UT)	0	0	0	0	0	30	0	0	30
17	Lakshadweep (UT)	0	0	30	0	0	0	0	0	30
18	Madhya Pradesh	269	492	597	1164	1616	535	180	448	5301
19	Maharashtra	660	829	561	883	1275	206	240	150	4804
20	Manipur (NER)	30	30	30	60	0	0	0	0	150
21	Meghalaya (NER)	0	0	0	0	0	30	0	0	30
23	Nagaland (NER)	30	0	30	0	0	0	0	0	60
24	Orissa	0	931	268	567	511	180	120	120	2697
25	Puducherry (UT)	0	62	0	0	0	0	30	30	122
26	Punjab	30	32	141	120	84	27	149	30	613
27	Rajasthan	53	581	597	775	1116	351	438	360	4271
28	Tamil Nadu	122	436	672	912	1132	249	210	120	3853
29	Telangana	90	274	600	950	1401	406	90	30	3841
30	Tripura (NER)	60	0	28	60	30	0	0	0	178
31	Uttar Pradesh	185	664	795	964	1604	548	325	480	5565
32	Uttarakhand	60	311	78	231	263	89	30	58	1120
33	West Bengal	0	556	564	1313	1566	150	150	120	4419
	Total	**2606**	**8407**	**8167**	**11912**	**16074**	**4363**	**2648**	**2330**	**56507**

(b) Vayumitra Programme :

Vayumitra Skill Development Programme (VSDP) has been launched by Ministry of New and Renewable Energy assigning the task to National Institute of Wind Energy (NIWE), Chennai for creating skilled and trained manpower for Wind power projects with a target to develop over 5000 no. trainees during the period FY 2021-22 to 2023-24. A total of 1846 no. of candidates (196 no. trainers and 1650 no. of participants) were trained under VSDP by March, 2024.All the1650 participants have been assessed by Skill Council for Green Jobs (SCGJ) and were awarded Certificates by National Skill Development Corporation (NSDC) of Ministry of Skill Development and Entrepreneurship (MSDE), Government of India. Three batches of ToP programs are currently ongoing with 330 participants. An exclusive web portal (https://vsdp.niwe.res.in/) has been developed to showcase the information related to the programme such as Master Trainer, Training of Trainers, Training Partners, Training Centers, Training of Participants, Participants Eligibility Criteria, Program dates and schedules, etc.

(c) Jalurjamitra Programme:

Ministry has launched the Jal-Urjamitra Skill Development Programme to train technicians for maintenance of Small Hydro Power Projects with a target to develop over 1700 no. of skilled manpower for the period of 5 years i.e. FY 2021-22 to 2025-26. Hydro and Renewable Energy Department, Indian Institute of Technology, Roorkee is coordinating the programme. HRED, IIT Roorkee has empanelled 8 Training Centres (TCs) to impart training under Jal Urjamitra skill development programme. Up to March 2024, 196 no. of candidates and 37 no. of trainers have been trained.

11.2.4 National Renewable Energy Internship Scheme (NREI)

Under the National Renewable Energy Internship (NREI) programme, the Ministry provides internship opportunity to students pursuing under-graduate, post graduate degree or research scholars enrolled in recognized institutions or universities within India or abroad, as Interns to understand the various activities/policies/schemes in RE sector.

11.2.5 Support to Higher Educational Institutions for Laboratory Upgradation

In order to encourage the institutions to include education/training renewable energy courses, the financial support for laboratory up-gradation is provided to enhance their capacity for conducting M. Sc., M.Tech., Ph.D courses in renewable energy. One time grant of Rs. 50 lacs each has been sanctioned to the following 4 institutes/ universities and funds of RS. 25 Lacs were released as advance.

i. Indian Institute of Technology, Kanpur
ii. Indian Institute of Technology, Roorkee
iii. Cochin University of Science and Technology, Kochi
iv. JamiaMillialslamia University, New Delhi

11.3 E-GOVERNANCE/INFORMATION TECHNOLOGY (IT) INITIATIVES

The Ministry aims to digitize it's all activities through use of the IT tools. The DGQI score of MNRE has improved from 2.26 to 2.88 in 5.0-point scale during the year. MNRE has developed and is maintaining following web portals and Mobile apps for transparency in operations and better service delivery to stakeholders under Digital India Initiative of the Government of India:

(a) **Ministry's Official Website (https://mnre.gov.in):** Ministry's official website has been redesigned and redeveloped in SWAAS (Secure, Scalable, Sugamya (Accessible) cloud service) platform. The new website was made live in October 2023. It is a bilingual website (Hindi and English) for information on all its schemes, physical achievements and division officers.

(b) **National Portal for Rooftop solar (https://solarrooftop.gov.in/):** An online portal with simplified procedure for residential consumers to have flexibility to get the rooftop solar plant installed by themselves or through vendor of their choice. This portal has been developed to simplify the procedure for Rooftop Solar Programme Phase -III to achieve cumulative capacity of 40,000 MW by 2026. It is a single portal across country for installation of solar rooftops. The portal has been integrated with DBT SANDES, PRAYAS and NGO DARPAN.

(c) **Human Resource Development (HRD) Portal https://hrd.mnre.gov.in):** A portal developed to institutionalize renewable energy education and training to meet the requirement of qualified and trained manpower in the country under five different schemes. Beneficiaries can submit online applications/proposals for following programmes:

i. Short term trainings and skill development in renewable energy
ii. Fellowships for higher studies and research in renewable energy
iii. Enhancement of Renewable Energy education and training infrastructure
iv. Renewable Energy Chair
v. National Renewable Energy Internship Programme

(d) **CCDC (Concessional Custom Duty Certificate) solar (https://scms.gov.in/):** This portal is for facilitating issuance of concessional custom duty certificate for import of components required for setting up of new solar power projects.

(e) **CCDC (Concessional Custom Duty Certificate) Wind https://ccdcwind.gov.in/):** This portal is for issuance of concessional custom duty certificate for import of components required for manufacturing of wind turbines.

(f) **Biourja Portal (https://biourja.mnre.gov.in/):** This portal has been developed to submit and process applications under following schemes"
i. Energy from urban, Industrial, Agricultural Wastes/Residues and Municipal Solid Waste
ii. Promotion of Biomass-based Co-generation in Sugar Mills and Other Industries in the Country.

(g) **Biogas Portal (https://biogas.mnre.gov.in/):** This is a central portal for beneficiaries to submit applications for installation of small and medium biogas plants. The process of installation followed by inspection procedures for installers and inspectors has been streamlined through the portal. A Mobile application for the same is also under development.

(h) **Research and Development (R&D) Portal (https://serviceonline.gov.in/dbt/):** R&D portal facilitates online submission and processing of renewable energy related R&D proposals.

(i) **PM KUSUM Portal (https://pmkusum.mnre.gov.in/landing.html):** The portal has been developed for implementation and monitoring of PM KUSUM scheme, which is meant for farmers

(j) **Solar Street Light Portal (https://ssl.mnre.gov.in/):** The portal has been developed for monitoring the implementation of solar street lights under the Solar Off-Grid and Decentralized Solar PV Applications Programme Phase III.

(k) **AkshayUrja Portal (https://akshayurja.gov.in):** This portal act as a central repository for renewable energy data such as RE potential, installed RE capacities, & Generation. The portal provides features such as data analysis and report generation regarding power potential, installed capacity and power generation in respect of solar, wind, small hydro, bio energy & waste-to-energy plants, and off-grid components.

(l) **Indian Renewable energy Idea exchange portal (IRIX) (https://irix.gov.in):** IRIX is a real-time idea exchange platform for the Global RE community to ideate, innovate and incubate in the renewable energy sector. It encourages exchanging of ideas, sharing knowledge and potentially finding solutions related to Renewable Energy Resources.

(m) **ALMM Portal:** The portal is being developed to manage procedural framework for the implementation of MNRE's Approved Models and Manufacturers of Solar Photovoltaic Modules. It will enable manufacturers to include their PV products in the ALMM list by modules of new applications, add additional models at existing facilities, setting up a new manufacturing facility, add Co-ALMMs and Renewals.

(n) **Solar Power Portal:** The portal is being developed to facilitate the solar power project developers to set up projects in a plug and play model. It will capture details of Solar Parks being constructed under the scheme "Development of Solar Parks and Ultra Mega Solar Power Projects". It also encapsulates monitoring of state wise physical & financial progress under scheme "Intra-State Transmission System (InSTS) GEC-II scheme".

(o) **Intra MNRE:** The portal is being developed for managing services being used in MNRE premises such as management of inventory, IT assets, canteen, conference room booking, vehicle management etc. Conference Room and Vehicle booking modules have already been launched. Role based dashboards are being developed for MNRE Officers for details on budget and physical achievements (overall, division wise and scheme wise).

(p) **Gati Shakti:** The portal is under development to map the layers and coordinates of the large-scale projects under solar, wind, hybrid (solar and wind), solar parks, solar PV manufacturing plants across India.

(q) **National Green Hydrogen Portal:** NGHM portal is being developed as a central point of information and data dissemination for those interested in the journey of India towards becoming a global green hydrogen hub.

(r) **HRMS:** e-HRMS is a common application tool for personnel management activities such as leave, posting, promotion, transfer, maintenance of service book, etc. It automates and digitizes the human resource processes, enhancing efficiency and transparency within the government organisation. It provides a user-friendly interface to access and manage various HR-related tasks such as Promotion, Transfer/Posting, Role Management, Bill Reimbursements, Leave applications, Circulars/OMs/Orders, and more. It is designed to ensure data privacy and security.

(s) **eOffice:** In a step forward for paperless work in office space, the Ministry has fully implemented eOffice which is meant for effective processing and online movement of files and receipts/ letters. It aims to contribute significantly towards transforming the core of the Government working which eventually would bring desirable values of transparency, efficiency, accountability, and faster decision-making.

11.3.1.1 Vigilance Awareness Week 2023/Cyber Security Trainings

As per the directive received from Central Vigilance Commission (CVC), Vigilance Awareness Week 2023 was celebrated for 3 months (16th August 2023 to 15th November 2023). The following activities such as trainings/webinars, quizzes, circulars were organized under Vigilance Awareness Week:

1. Cyber Security Insights
2. eHRMS Version 2.0 Training
3. Cyber Hygiene Session cum Training
4. Cyber Hygiene Quiz
5. Development of Vigilance Monthly Report on Intra MNRE Dashboard
6. Walkthrough Session on Conference Room Booking & Vehicle Booking Modules of Intra MNRE Portal

Apart from these, following trainings were also organized:

1. One week training on "Artificial Intelligence & Machine Learning" by C-DAC
2. Webinar on "Safe Use of Social Networks" under Cyber JagrooktaDiwas
3. Webinar on "Working Safely in different Digital Platforms" under Cyber Jagrookta Diwas



Fig. 1: Cyber Hygiene Session cum Training by Indian Cyber Crime Coordination Centre (I4C)

11.3.2 Vigilance

The Vigilance Division of the Ministry of New and Renewable Energy (MNRE) handles complaints against officers of the Ministry of New and Renewable Energy in accordance with CVC/DoPT guidelines. Division also examines complaints against Board Level officers of two CPSUs, namely the Indian Renewable Energy Development Agency Limited (IREDA) and the Solar Energy Corporation of India Limited (SECI), and supervises vigilance work in organizations under its purview, namely three autonomous bodies: the National Institute of Solar Energy (NISE), the National Institute of Wind Energy (NIWE), and the SardarSwaran National Institute of Bio-Energy (SSS-NIBE). The Vigilance Division is also entrusted with the task of maintaining and scrutinizing Annual Performance Appraisal Reports (APARs) and Immovable Property Returns (IPRs) of officials within the Ministry.

The complaints received by the Vigilance Division during the year 2023 were examined in accordance with the applicable rules and guidelines, and necessary actions were taken wherever there were violations of the rules.

The "Vigilance Awareness Week, 2023" was observed in the Ministry from October 30, 2023, to November 5, 2023. This year's theme for the Vigilance Awareness Week was "Say no to corruption, commit to the nation." During the week, the Integrity Pledge was administered by the Secretary, MNRE, to all staff and officers. Banners and posters related to Vigilance Awareness Week, 2023 were displayed at prominent locations within Atal AkshayaUrjaBhawan. A lecture on Preventive Vigilance was organized, and various activities, including an Essay competition, a Poster making competition on vigilance issues, a Debate competition, and an Extempore Speech competition, were conducted during the week.

To promote awareness among citizens and officials about complaints under the Public Interest Disclosure and Protection of Informer (PIDPI) Act, social media campaigns were conducted, and banners were displayed at accessible locations within the Ministry premises.

11.3.3 Library

The Library of the Ministry of New and Renewable Energy acts as a reference center and knowledge house in the field of renewable energy. At present 12,814 books (including gifted books) are available in the library covering diverse subjects such as Renewable Energy, Climate Change, Natural Sciences, Sustainable Development, History, Sociology, Indian Literature, Computer Science, etc. The collection in the library also includes books of general interest like food, cooking, sculpture, painting, mountaineering, etc.

(ii) The Library Committee constituted in the Ministry scrutinizes and recommends the books, periodicals etc. for procurement by the library.

(iii) The library is currently subscribing to 33 periodicals in Hindi and English languages. Besides, 23 newspapers in Hindi and English languages are also being subscribed. The library is using cloud-based library software e-granthalaya version 4.0 for accessing the Library Catalogue to library users, Circulation (issue-return) and Membership Management etc.

11.3.4 RIGHT TO INFORMATION ACT

The Ministry is implementing the Right to Information (RTI) Act, 2005 as per the laid down guidelines of Department of Personnel and Training (DoPT), Central Information Commission. The Procedure / other details regarding seeking information under RTI Act, 2005 are available at the MNRE website www.mnre.gov.in.

The Progress Report in terms of RTI Application or First Appeals received, disposed-of as well as pendency during the period (01.04.2023 to 31.03.2024) is given in the following Table

RTI Applications / Appeals of the Ministry for the Period 01.04.2023 to 31.03.2024

Item	Received	Disposed of	Pending as on 31.03.2024
RTI Applications	643	603	40
First Appeals	36	30	06

The 3rd Party Transparency Audit proactive disclosure was uploaded on the Ministry's website (https://mnre.gov.in), which contained information as required under the Section 4 of the RTI Act, 2005. It also contains the details of the Department's functions along with its functionaries etc. as required under section 4(1) (b) of the RTI Act, 2005

The Ministry has designated Central Public Information Officer (CPIO) and First Appellate Authorities (FAA) to respond the RTI applications and first Appeals in accordance with subjects assigned to them. The list of CPIOs and FAAs is given in the following table. Nodal officer of RTI coordinates all the physical and online applications and persuades the CPIOs and FAAs to reply them within the stipulated time lines.

List of Designated Central Public Information Officers (CPIOs) and First Appellate Authorities (FAAs) based on re-allocation of work:

S.No.	Subject	Name of CPIOs & Designation (Shri/Ms./Mrs.)	Name of FAAs & Designation (Shri/Ms./Mrs.)
1.	i. Comments on EFC/SFC/ Cabinet Notes/Concept Paper received from ther Ministries/Departments; ii. matters related to NITI Aayog monitoring, including Annual PM Infrastructure Sector review & Output Outcome Monitoring Framework (OOMF); iii. Regular updation of E-samiksha portal & other portals including updation of Budget announcements.	Shobhit Srivastava, Scientist 'E'	J. Rajesh Kumar, EA

S.No.	Subject	Name of CPIOs & Designation (Shri/Ms./Mrs.)	Name of FAAs & Designation (Shri/Ms./Mrs.)
2.	All Matters related to National Infrastructure Pipeline	Shobhit Srivastava, Scientist 'E'	Dr. Pankaj Saxena, Scientist 'G'
3.	Administration	Arunava Sengupta, US	Pankaj Gupta, DS
4	i. Monthly RE progress data compilation and updation; ii. Preparation of monthly Cabinet DO letter; iii. Preparation of brief for perusal of Hon'ble Minister meetings; iv. Preparation of background notes / PPT for meetings of standing Committee/Power Ministers Conference/RPM meeting/other review meeting etc.; v. Inputs for speech of Hon'ble Prime Minister Independence Day Address/ Hon'ble Finance Minister Budget speech etc.; vi. Preparation of year end review/brief write ups for PIB; vii. Inputs for Annual Report including chapter of NE Region; viii. ATR on recommendations of Vision Document.	DipeshPherwani Scientist 'D'	Dr. Pankaj Saxena, Scientist 'G'
5	National Green Hydrogen Mission	Anubhav Uppal Scientist 'D'	Sujit Pillai, Scientist 'F'
6	Policy and Regulatory Matters including RPO (beyond 2022-2023, Compliance Monitoring), REC Policy, Directorate for Regulatory Compliance	Koushik Goswami, DGM	J K Jethani, Scientist 'F'
7	Energy Storage (Mission on Transformative Mobility & Battery Storage); E-Mobility [Charging Infrastructure, Electric Vehicle for Surface transport, National Board for Electric Mobility (NBEM)]	PNBV Chalapathi Rao, Scientist 'D'	Kuldeep Rana, Scientist, 'E'

S.No.	Subject	Name of CPIOs & Designation (Shri/Ms./Mrs.)	Name of FAAs & Designation (Shri/Ms./Mrs.)
8	Rooftop Solar; Solar City	Shital Prashad Kalra, US	Divyanshu Jha, DS
9	All matters of SECI	Shital Prashad Kalra, US	Sanjay Karndhar, Scientist 'E'
10	International Solar Alliance (ISA); Multilateral initiatives;	Aseem Kumar, Director	Dinesh Dayanand Jagdale, JS
11	G-20 Coordination	Anant Kumar, Director	Dinesh Dayanand Jagdale, JS
12	PM Gati Shakti	Kuldeep Rana, Scientist, E	Dilip Nigam, Scientist 'G'
13	Solar Park Scheme	P.V. Tarun Saketh, Scientist 'C'	A. S. Parira, Scientist 'E'
14	Transmission, Green Energy Corridor	Rohit Thakwani, Scientist 'D'	Tarun Singh, Scientist 'E'
15	Clean Drinking water in Coastal Areas and Solar Powered Cold Storage	Rohit Thakwani, Scientist 'D'	Dr. A.K Tripathi, Scientist 'G'
16	Information Technology (IT)	Priya, Scientist 'C'	Anant Kumar, Director
17	Solar Parks Scheme & UMREPP Schemes,(Solar Parks in NE States, Jharkhand & Odisha UMREPP by other CPSUs), VGF Scheme; Rooftop PV and Small Solar Power Generation Programme (RPSSGP); GBI Scheme; Solar Cities and Green Building;NTPC-Bundling, NTPC-EPC Projects; Konark Scheme /Matters related to Department of Commerce; Solar projects in Ladakh under PMDP.	Aravindh MA, Scientist 'D'	A. S. Parira, Scientist 'E'
18	Lab Policy & Standards Quality Control	Vikram Dhaka, Scientist 'D'	Hiren C Borah, Scientist 'E'
19	All work related to Biomass Power Schemes and policies, Bio energy mission, Biomass cook-stove, Biomass Gasifier, Waste to Energy, All Administrative and Financial matters of NIBE	Vikram Dhaka, Scientist 'D'	Gaurav Mishra, Scientist, 'F'

S.No.	Subject	Name of CPIOs & Designation (Shri/Ms./Mrs.)	Name of FAAs & Designation (Shri/Ms./Mrs.)
20	Financing of RE	Gaurav Mishra, Scientist, 'F'	Ajay Yadav, JS
21	Development of RE in North East	Hiren C Borah, Scientist 'E'	J K Jethani, Scientist 'F'
22	Biogas Power (Off Grid Programme) National Biogas Programme, Biogas Training Centres	P M Barik, Scientist 'D'	Dr.Sangita M Kasture, Scientist 'G'
23	All Administrative matters of IREDA	Sunita Sajwan US	Tarun Singh Scientist 'E'
24	Off-Grid Solar PV Schemes and thermal applications including Decentralized Renewable Energy (DRE) livelihood application; Solar Village	V.S.S. Chaitanya, Scientist 'C'	J K Jethani, Scientist 'F'
25	PM KUSUM Scheme	Nikhil Gakkhar Scientist 'D'	Suman Chandra Director
26	HRD & Training including ITEC Innovation Centre	Gitanjali Virmani, US	VasantaV.Thakur, Scientist 'E'
27	Wind Energy (Offshore), Small Wind, Wind Energy (On-shore); Repowering and Hybrid Policies; CCDC Wind & Solar All Administrative and Financial Matters of NIWE	Rahul Rawat, Scientist 'D'	P K Dash Scientist 'E'
28	R&D (including Wind, Solar, Biomass, Hydrogen & Battery), New Proposals of R&D under consideration; Solar Water Heater;	Arun Kumar Choudhary, Scientist 'B'	Anil Kumar, Scientist 'E'
29	Old Schemes (Greening of Islands, Solar Thermal, Gir Forest Solarisation) New Technologies, Geothermal, Ocean/Tidal Energy	Anil Kumar, Scientist 'E'	Dr. A.K Tripathi, Scientist 'G'
30	CPSU Govt. Producer Scheme; Canal Top Solar Scheme; Solar Manufacturing scheme; Renewable Energy Industry Promotion and Facilitation Board (REIPFB); PLI Scheme for manufacturing of High Efficiency Solar Modules; Coordination for resolving Solar Manufacturers and Developers issues.	Mohd. Azmal Mansoori, Scientist 'C'	Sanjay Karndhar, Scientist 'E'

S.No.	Subject	Name of CPIOs & Designation (Shri/Ms./Mrs.)	Name of FAAs & Designation (Shri/Ms./Mrs.)
31	Guidelines & Standard Bidding Documents (SBDs),	Ayush Gupta, Scientist 'B'	Sanjay Karndhar, Scientist 'E'
32	Small Hydro Projects; PM's Package of Ladakh Renewable Energy Initiatives; PM Development & Reconstruction Package 2015 for Hydro Power for Jammu & Kashmir	S. K. Shahi, Scientist 'E'	Dr.Sangita M Kasture, Scientist 'G'
33	Direct Benefit Transfer (DBT) Cell, FDI Cell and GST Cell,	Mala Ram Sonwal Dy. Dir.	Shobhit Srivastava, Scientist 'E'
34	Climate Change and Coordination with MoEF& CC,	Tarun Valecha, Scientist 'B'	Suman Chandra, Director
35	Circular Economy	Tarun Valecha, Scientist 'B'	Kuldeep Rana, Scientist, 'E'
36	I & PA; Media / Social Media	A.K Manish, US	Anant Kumar, Director
37	AkshayUrja Magazine	A.K Manish, US	Dr. A K Tripathi, Scientist 'G'
38	Vigilance; Lokpal & Lokayukt	Sunita Dhewal, US	Aseem Kumar, Director
39	National Solar Mission (NSM)	Seema Srivastava, US	A. S. Parira, Scientist 'E'
40	International Relations (IR) and International Cooperation	Sunita Dhewal, US	Aseem Kumar, Director
41	Legal Cell	A.K.Singh, US	Pankaj Gupta, DS
42	Parliament Work/All Matters related to Parliament	A.K.Singh, US	Dr. Pankaj Saxena, Sci. 'G'
43	Public Grievances (CPGRAMS	A.K.Singh, US	Pankaj Gupta, DS
44	IFD	A.K.Singh, US	Pankaj Gupta, DS
45	Budget Monitoring; Audit	Sunita Sajwan, US	Pankaj Gupta, DS
46	RTI Matters	Mala Ram Sonwal, Dy. Dir.	Pankaj Gupta, DS
47	Cash Section	Anjana, SO & DDO	M R Sonwal, Dy.Dir.

S.No.	Subject	Name of CPIOs & Designation (Shri/Ms./Mrs.)	Name of FAAs & Designation (Shri/Ms./Mrs.)
48	Library	Sunita Sajwan, US	Shobhit Srivastava, Scientist, 'E'
49	Hindi	S. K. Shahi, Scientist 'E'	Dr. A.K Tripathi, Scientist 'G'
50	PAO, Budget	Dharmendra Kumar Singh, Sr. Accounts Officer	Maneesh Dwivedi, DCA
51	All administrative and financial matters of NISE	Seema Srivastava, US	Anant Kumar, Director
52	Office of Hon'ble Minister, NRE	D K Pandey, US	Pankaj Gupta, DS
53	RE in UTs	Priya, Scientist 'C'	Dr. A.K Tripathi, Scientist 'G'
54	Study of IT tools like Artificial Intelligence, Data Mining, Block chain and Deep Learning for development of Renewable Energy	Sanjay Prakash Bhagat, Scientist 'C'	Dr. A.K Tripathi, Scientist 'G'

11.3.5 WOMEN IN RENEWABLE ENERGY (RE) INITIATIVE

Under various schemes and programs, the Ministry has been encouraging the participation of women in the renewable energy sector. To push the women-centric policies, programs, and interventions required in the RE sector, the Ministry constituted a committee on 08.03.2022 with the mandate of promoting women-centric policies, programs, and interventions within the Renewable Energy (RE) sector. The committee comprises members from the MoWCD, MoRD, MoPR, MSME, ISA, SPDA, NABARD, IBA, CII, and FICCI. Ministry has organized multiple policy workshops, outreach events, and discussion platforms aimed at empowering women in the Renewable Energy sector. These initiatives provide women with opportunities to share their inspiring stories and experiences.

On World Environment Day dated 05.06.2023, the Ministry organized an event "Women in Renewable Energy: A Dialogue on Policy, Technology, Skilling, and Finance" in New Delhi. Speaking at the event, Hon'ble Minister, NRE emphasized the significance of developing women-centric policies and implementation frameworks in the renewable energy sector. He recognized how women are more effective in bringing about change at the grassroots level through community engagement and household-level action. He noted that women, especially in rural areas, can benefit from Decentralized Renewable Energy (DRE) and gain reliable livelihood opportunities.



On the occasion of International Women's Day, on 08.03.2024, the Ministry organized an event "Women in Renewable Energy: Inspiring Gender Inclusion through Skill Development and Targeted Policies for Green Jobs" in New Delhi. This event aimed to deliberate on bridging policy gaps for inclusive green employment with a focus on skilling & capacity building and to share learnings & recommendations from the experience of women leaders in the renewable energy sector. The event was attended by stakeholders across the renewable energy value chain, comprising Central and State Government officials and representatives of multilateral organizations, financiers, technology suppliers, think tanks, NGOs and civil society.

CHAPTER 12

INTERNATIONAL COOPERATION IN RENEWABLE ENERGY

INFORMATION AND PUBLIC AWARENESS PROGRAMME

12.1 The International Relations (IR) Division of the Ministry has been continuously engaging with several Ministries/Departments of the Government of India, Indian Missions, Foreign Diplomatic Missions located in India, Multilateral International Organizations and Agencies, Regional Groupings and development banks among others for promoting international cooperation in the field of Renewable Energy.

12.2 Joint Working Groups (JWGs), Taskforce meetings, Bilateral and Multilateral meetings were also conducted for identification, selection and formulation of joint activities. The delegations were led at the level of senior officers from the Ministry for the purpose of these meetings and events. Details of Joint Working Groups Meetings held during the FY 2023-24 are as under:

1	JWG meeting India-Saudi Arabia on virtual mode	5th April, 2023
2	1st meeting India-Australia Solar Taskforce	20th April, 2023
3	JWG meeting India-Saudi Arabia on virtual mode	30th May, 2023
4	2nd Joint Working Group meeting India-UK on virtual mode	7th June, 2023
5	Joint Working Group meeting India-EU virtual mode /Physical	27th July, 2023
6	3rd meeting India-Norway Taskforce on Energy	27th October, 2023
7	5th JWG meeting India-Denmark virtual mode /Physical	08th Nov. 2023
8	1st JWG meeting India-Sri Lanka	11th March, 2024

12.3 TheMinistry has taken several initiatives for promotion of Renewable Energy. The Ministry has signed Memorandum of Understandings (MOUs), Joint Declaration of Intents (JDIs) with various countries and institutes in the field of New & Renewable Energy.

12.4 The following Memorandum of Understandings (MoUs) have been signed in the FY 2023-24

i Memorandum of Understanding between the Government of the Republic of India and the Government of the Democratic Socialist Republic of Sri Lanka on Cooperation in the field of Renewable Energy signed on 21st July, 2023.

ii Memorandum of Understanding between the Government of the Republic of India and the Government of the Kingdom of Saudi Arabia on Cooperation in the field of Energy signed on 10th September, 2023.

iii Memorandum of Understanding between the Government of the Republic of India and the Ministry of Investment of United Arab Emirates on Investment Cooperation in Renewable Energy Sector signed on 9th January, 2023.

iv Memorandum of Understanding between the Government of the Republic of India and the Government of Federal Republic of Nigeria on Co-operation in the field of Renewable Energy signed on 22 January, 2024.

12.5 Some of the prominent bilateral/multilateral engagements in the financial year include the following:

a. India-US Renewable Energy Technology Action Platform (RETAP);

b. Australia-India Solar Task Force deliberations along with launch of Australia-India Hydrogen Task Force;

12.6 ENGAGEMENT WITH INTERNATIONAL RENEWABLE ENERGY AGENCY (IRENA)

International Renewable Energy Agency (IRENA) is an intergovernmental organization that supports countries in their transition to a sustainable energy future, and serves as a principal platform for international cooperation, centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bio-energy, geothermal, hydro power, ocean, solar and wind energy in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity.

India became Member of International Renewable Energy Agency (IRENA) in 2009. India regularly participates in the Council and General Assembly meetings of IRENA. India had assumed the Presidency of IRENA General Assembly in 2023.

The 13th session of the IRENA General Assembly was held on 14-15 January, 2023 at Abu Dhabi, UAE under India's Presidency. Hon'ble Minister for Power, New and Renewable Energy presided over the assembly proceedings;

Part-I of the 14th International Renewable Energy Agency (IRENA) Assembly and related meetings were held in virtual format on 15th January, 2024. Being the President of the 13th Assembly, India, represented by Hon'ble Minister for Power, New and Renewable Energy, opened Part-I of the Assembly and thereafter handed over the Presidency to Rwanda for the 14th Assembly.

12.7 ENGAGEMENT WITH INTERNATIONAL SOLAR ALLIANCE (ISA)

ISA is an inter-governmental treaty-based international organization with a global mandate to catalyse global solar growth by helping to reduce the cost of financing and technology for solar. The ISA was launched on 30th November 2015, and on 6th December, 2017, ISA became the first intergovernmental international organization headquartered in India. As on 31st March, 2024, 119 countries have signed the ISA Framework Agreement and out of which, 98 countries have also ratified the Framework Agreement of the ISA.

The International Solar Alliance (ISA) is an observer to the United Nations Framework Convention on Climate Change (UNFCCC) and actively participated at COP28. ISA is also on observer status at the UN General Assembly.

The 6th Session of the ISA Assembly was held in New Delhi 31st October, 2023. The ISA Secretariat has also conducted a series of technical sessions on various strategic initiatives of the ISA and other emergent issues in the solar and clean energy sectors on 1st November, 2023.

12.8 COOPERATION UNDER QUAD FRAMEWORK

The Quad Climate Working Group has organized its work according to three core themes: 1) Climate Ambition, 2) Clean Energy Innovation and Deployment, 3) Adaptation, Resilience and Preparedness.

The Clean Energy Innovation and Deployment pillar is co-chaired by MNRE from the Indian side. The Indian side also comprises of representatives from MoP, MoEFCC, MoPNG, DBT and MEA. The pillar's current work focuses on key priority areas like Clean Hydrogen/Ammonia, Methane abatement in natural gas sector, Clean energy supply chains and CCUS/Carbon Recycling.

Under the Clean Energy Innovation and Deployment pillar, India has taken the lead on establishing the Quad Clean Hydrogen Strategic Initiative. India organized the first meeting of the Quad taskforce on Hydrogen Regulations, Codes and Standards (RCS) on 17 March 2023 in virtual mode with participation of representatives from Government/Institutions of member countries.

The Ministry is further working on high-impact deliverables for the upcoming Quad Leaders' Summit, which India will host in 2024.